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Virtual Worlds in Pre-Service Teacher Training
Classroom Technology Acceptance and Behavioural Change

Camilleri, Vanessa

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By

Vanessa Camilleri

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ABSTRACT

Human behaviour in educational contexts can be facilitated and supported by technology enhancements. This thesis considers a virtual 3D world as one such technological enhancement and explores its use in supporting technology acceptance in pre-service teacher education. The adaptation of different educational technology tools can often be challenging for teachers due to negative perceptions, lack of experience and a fear of technology. This thesis investigates the role that immersion within virtual environments can play to change perceptions, increase experience with and overcome fears associated to adopting technologies in the classroom. For this reason, this thesis asks the following questions: *What factors and indicators show a positive influence on the participants' perceptions of learning technologies? Do the virtual world (VW) activities encourage more VW connections and interactions inside the VW? What are the pre-service teachers' reflections on learning in the VW setting? How is the learning experience in the VW applied to the real world classroom practice?* This study focuses on the use of classroom technologies in a pre-service teaching program at the University of Malta. PreVieW (**P**re-service teachers **V**irtual **W**orld experience) is evaluated using quantitative, qualitative and social network analysis (SNA). The combination of these three methods is used to measure the extent of the VW's influence as a medium in affecting the participants' perceptions about classroom technologies and their behavioural intentions to adopt technology during teaching. The results show that the VW experience has an overall significant positive effect on the self-reported perceptions of technology. Factors affecting this result are perceived ease of use, experience and attitude, whilst social network graphs show that VW activities are responsible for social group formations. Participants attribute the strengths of PreVieW to its flexibility and learner-centric activities whilst finding the technical setup as challenging. Participants reflect on the cultural differences in the understanding of teaching and learning in the VW as opposed to a traditional classroom. Findings lead to a deeper understanding of the human-computer interactions in a VW set in a formal learning experience. Following this a model is recommended proposing the integration of a VW experience in a teacher education program together with a number of propositions to enrich learning in a 3D VW.

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GLOSSARY OF ACRONYMS

3D – 3-Dimensional

AI – Artificial Intelligence

AR – Augmented Reality

BI – Behavioural Intention

BIC – Bayesian Information Criterion

ECTS – European Credit Transfer and Accumulation System

ELM – Exploratory Learning Model

LA – Learning Analytics

LMS – Learning Management System

MMORPG – Massively Multiplayer Online Role Playing Game

MOOC – Massively Open Online Course

MUVE – Multi User Virtual Environment

MVP – MedBiquitous Virtual Patient

NCF – National Curriculum Framework

NPC – Non-Player Character

OE – Open Education

OER – Open Educational Resources

OU – Open University

PEOU – Perceived Ease of Use

PGCE – Post Graduate Certificate in Education

PreVieW – Pre-service teachers Virtual World (experience)

PU – Perceived Usability

SEM – Structural Equation Modelling

SL – Second Life

SNA – Social Network Analytics

TAM – Technology Acceptance Model

TPACK – Technology Pedagogy Content Knowledge Model

UoM – University of Malta

VR – Virtual Reality

VW – Virtual World

WoW – World of Warcraft

GLOSSARY OF TERMS

Blended Learning – A form of learning that effectively combines face-to-face and online interactions in varying degrees. There is not one specific blend, but the different modalities for interaction depend on the context (Bonk & Graham, 2006).

Collective Intelligence – Knowledge that is made available and accessible by members of any given community (Levy, 1999). Jenkins (2006b.) further describes it as "a situation where nobody knows everything, everyone knows something, and what any given member knows is accessible to any other member upon request on an ad hoc basis".

Communities of Inquiry – A model which sees collaboration in a group merge with scientific inquiry to emerge with a given solution to a problem. Communities of inquiry was first introduced by Dewey, but was subsequently developed into a model for eLearning by Garrison et al. (2010). This model uses three main components to achieve learning: cognitive, social and teaching presence.

Communities of Practice – A term coined by Wenger (1999) to describe the role of communities in the construction of meaning for learning. "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger & Trayner, 2013).

Connectivism – A theory first put forward by Siemens (2004) and Downes (2008). The theory presupposes that in the digital information age knowledge is the product of influences from a number of sources, both human and non-human. When an individual is able to reconcile all the connections from the various information sources in a meaning-making exercise, learning happens.

Cybergogy – This term is used to describe learning in youths and adults facilitated by technology and digital practices (Wang & Kang, 2006). The Cybergogy model designed by Wang & Kang (2006) promotes engagement in online learning by means of three intersecting factors: social, cognitive and emotive.

Deep Learning – This refers to learning that is grounded in reflection and which offers an understanding of the matter described. Dewey (1997) was one of the pioneers who posited that such a deep learning is ingrained in experience followed by a reflection process that would help the individual obtain deeper insights into the practice.

eLearning –Although this term was initially coined in the early 1990s and made reference to learning by means of electronic resources, it has since evolved to encompass practices of interaction and access to resources using electronic and digital media, tools and applications (Holmes & Gardner, 2006).

Engagement – In this thesis this is also referred to as learner engagement. Engagement refers to the extent of participation and interaction which learners have with the formalised institution setting, both at the human, as well as the curricular and extra-curricular level. Willms (2003) describes learner engagement as being made of two main components: "a *psychological* component pertaining to students' sense of belonging at school and acceptance of school values, and a *behavioural* component pertaining to participation in school activities" (2003, p. 8).

Flow – Csìkszentmihàlyi (1991) proposed this term to indicate the motivation and interest an individual might invest in a specific task or activity. An optimal state of flow would indicate that the individual has achieved a balance between challenge and boredom, and that he/she has achieved a state of focused motivation on completing the task.

Forum – This term is used to describe online forum activities most often associated with online or eLearning. In these activities, learners are expected to engage in text-based interactions that may lead to collaboration and enriched communication practices.

Identity – This refers to the identities established in virtual communities. The identities in the virtual space are manifested by means of the individuals' behaviour, appearance and their interactions. In the virtual space an individual might have more than one identity depending on the context.

Immersive Environment – This refers to a virtual environment that combines design strategies that would enhance the belief that the individual is *inside* the environment. Such strategies would include actions, symbols and sensory factors (Dede, 2009).

Learning Analytics – According to the Society for Learning Analytics Research (SoLAR), "Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (Ferguson, 2012, p. 2).

Learning Technologies – For the purpose of this thesis, learning technologies include the different media, technology-based applications and tools that can be used to facilitate and support learning. Learning technologies also include the 21st century digital practices that would require a specific set of skills and attitudes.

Metaverse – The Metaverse is a reference to an immersive space initially described by Stephenson in his 1992 science fiction novel 'Snowcrash' (Stephenson, 2000). It is used to encapsulate virtuality and the different media that can sustain it, such as virtual worlds, virtual reality, augmented reality and the Internet.

Online Learning – Online learning refers to learning which is facilitated and supported by the Internet.

Open Education – This term refers to an education which does not have institutional boundaries and barriers and which is committed to offering access to all the individuals with intent to learn. This would include access to resources, learning material and content, subject expertise and peer interactions.

Pedagogy – This term may have different interpretations. In this thesis, this is interpreted in the broader education context and does not refer to traditional instructional methods. Pedagogy is traditionally defined as the art and science of teaching towards specific goals and this might narrow the creative and critical mind (Hinchliffe, 2001).

Pre-service Teachers – This term in the context of this thesis refer to people enrolled at a higher education teacher education program. At the end of this program of studies

the graduates would be able to assume a professional teaching position at any one of the state, church or independent schools in Malta.

Presence – In this thesis this term refers to a virtual presence of the participants as avatars, able to explore the VW and interact with each other and with the VW objects as well as a social presence of the participants in the VW measured by the number of text-based interactions between them as avatars.

Self-directed Learning – This type of learning "describes a process by which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Smith, 2002).

Self-efficacy – This term was described by Bandura (1994) as the belief in oneself which leads the individual to perform and complete tasks and actions successfully. In this thesis, self-efficacy also refers to one's confidence in their ability to handle technology applications.

Social Constructivism – A theory posited by Vygotsky (1997) that describes how meaning making can be aided by the social context in which the learner is found. Therefore, community and collaborative activities become an important influence on the learning.

Social Networks – This term refers to the connections between individuals in a community. Christakis and Fowler (2011) define this as "an organised set of people that consists of two kinds of elements: human beings and the connections between them…Real, everyday social networks evolve organically from the natural tendency of each person to seek out and make many or few friends, to have large or small families, to work in personable or anonymous workplaces" (p. 13).

Teaching Practice – This term refers to a period of experience in the classroom which pre-service teachers following their PGCE course at the University of Malta are required to carry out. During the course of the investigation in this thesis, teaching

practice had an influential role on the VW behaviour and in turn, the VW had an important role on the pre-service teachers' classroom practice.

Virtual Learnscapes – This term is used in the thesis to represent the mapping of the virtual learning environments to pedagogically driven principles.

Virtual Learning Environment – This term broadly encompasses virtual spaces that are used for learning. Such environments can include Learning Management Systems (LMS), Multiuser Virtual Environments (MUVEs), Virtual Worlds (VWs), and Serious Games.

VW Archetypes: Aldrich (2009) discusses learning archetypes in a VW as being learning opportunities that are facilitated by the 3D space. This would include role-playing through an immersive setting, treasure hunts, guided tours, orienteering and co-creation. Although such learning activities may be possible in a real world environment, it may be unfeasible and unsustainable. A 3D VW facilitates and supports such practices through its 3D graphics, embedded intelligence and possibilities for navigation and creation in the environment.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Human behaviour in educational contexts can be facilitated and supported by technology enhancements. This thesis considers a virtual 3D world as one such technological enhancement and explores its use in supporting technology acceptance in pre-service teacher education. The investigation focuses on how a Virtual World (VW) can influence teacher perceptions and facilitate greater acceptance of the use of innovative classroom learning technologies. It provides a deeper understanding of the human-computer interactions occurring during a learning experience held inside a 3D VW by providing data about the changes in the learners' attitudes towards classroom learning technologies, the networks that are formed inside the VW and insights into the challenges, strengths and opportunities of the learning experience emergent from the VW. As a result of this, the thesis outlines the implications for the integration of VWs in teacher education programs and offers a set of proposals for their use as media that can affect user behaviour towards different learning technologies.

1.1 THE CONTEXT

In this thesis learning is seen as a process that is ingrained in social practices driven by connections and social ties facilitated by the online medium. These views and perspectives emerge from an epistemological stance grounded in social learning theories, with specific focus on Connectivism (Siemens, 2004). Connectivism (Siemens, 2004; Downes, 2008) is described as a theory for learning in the digital age and is characterised by a definition of learning as a meaning making activity, that is a product of human and information networks guided by cognition and emotion, as well as multimodal connections supported and facilitated by the online environment. For this reason the literature and emerging research is chosen on the basis of current trends and practices that merge learning technologies, teachers' attitudes and behaviour towards classroom learning technologies and the use of alternative media

for modelling behaviour towards the adoption of learning technologies. In this thesis, the digital medium chosen to assist in modelling users' behaviour towards accepting and adopting learning technologies is a 3D social VW, due to its immersive potential to influence users's attitudes and behaviours.

The research reviewed in Chapter 3 indicates that there is a widespread problem in the way that teachers show an initial resistance to the adoption of new technologies for their teaching, especially those that might require new skills and competences (Chen, 2010). Findings presented in many of these studies indicate that teachers are not exploiting technology for the transfer of pedagogic values in the classroom, using technology only for communication (such as emails) or administrative purposes (such as lesson planning and resource preparation) (Teo, 2009; Abbitt, 2011; Sutton, 2011). The implication from these studies is that there is a lack of digital engagement when technology acceptance is low. The more the individuals adopt technology practices, the greater the likelihood that they become engaged with the technology which can lead to a deeper understanding of its application in practice. Transformation of educational practice can therefore become the result of effective technology practices. Effective technology practices have been defined by JISC (2009) as those practices of:

> employing a range of pedagogic skills to bring about the best possible learning for the widest variety of learners. This process undoubtedly draws on specialist skills and knowledge but in a digital age must also include the ability to "design, plan and orchestrate learning activities which involve the use of technology as part of a learning session or programme" (2009, p. 8).

This transformation of educational practice for the preparation of the future workforce is also one of the main issues addressed by the Europe 2020 strategy (Redecker, et al., 2010) driven by the changing societal needs as a result of the fast-paced advances in technology of the last decade.

This approach towards the transformation of teacher education is also reflected in Malta, the location of this investigation. The National ICT Strategy for Malta (2008, pp. 30-39) supports this same vision of a society that is more advanced in the use and application of Information and Communication Technology (ICT) – this is also

referred to as the 'knowledge society' and with its principle characteristics rooted in digital literacy. The strategy describes in detail seven main streams, three of which focus on e-education, training and eLearning with the uptake of more ICT-related skills leading to a more *digitally literate* society. The National Curriculum Framework (NCF) for Malta, proposed in 2011 (2011, pp. 11-15) emphasises the need for a practice which is not only contextualised within the current societal trends and practices, but which is founded upon knowledge ingrained in and applied to areas which are diverse in nature. Personalised and lifelong learning extending beyond the classroom time are also encouraged, and this implies that teacher-centric lessons need to be replaced with lessons of a more interactive and participative nature – an overall learner-centric approach that is defined by the social nature of the classroom. Although such an approach may not be without its criticisms, the stance taken by this thesis is that increased learner participation, self-directedness and activity in the area of learning technologies, may lead to greater adoption during teaching. Furthermore the thesis proposes that the modality in which this learner self-directedness is encouraged is key to supporting the acceptance and adoption of technology in the class. This thesis suggests that a 3D VW modality would help achieve this through its immersive characteristics.

The NCF, in addition, categorises eight (8) key learning areas, amongst which one finds the area of technology including digital literacy. The inference is that teachers can no longer use 20th century practices inside the classrooms. These practices focus more on the teacher as the 'sage on the stage' rather than on the learners as active participants. For teachers to change their practices they need to gain more confidence in the use of digital practices for learning. Such practices would encourage student activity and creativity to solve problems and overcome challenges related to the cross-curricular learning areas. Currently, the process which sees teacher practitioners all over the islands of Malta make use of online and digital learning tools to enhance their classroom-based teaching, has already kicked off. This also means that the teacher education program delivered by the Faculty of Education at the University of Malta, plays a vital role in empowering individuals entering the profession, with the skills and competences required to not only adapt to but to adopt technology-driven practices for teaching and learning. A number of theses have shown that the situation in Malta in relation to teacher perceptions about technology use and best practice is

not very encouraging (Gatt, 2009). Although teachers may be in favour of the use of technology, they might not always be fully aware of tools, applications and strategies that may be used in an innovative classroom environment.

Recent research trends are addressing the problem of how to support classroom teachers in making use of innovative technology practices that focus on a more learner-centric design (Chen, 2010). The lack of technology adoption has been attributed to a lack of technology acceptance. For this reason this thesis explores how technology acceptance and adoption can be mediated through the use of a 3D VW, as a medium that would help model pre-service teachers' behaviour. VWs offer an experience that can be exploited by the pre-service teachers to connect and interact together in a virtual environment whilst exploring and experimenting with different technology practices that could be used during their class teaching. The main research question therefore asks:

> *How does the use of a 3D VW influence pre-service teachers' perceptions and behaviour towards adopting learning technologies for the classroom?*

The hypothesis following from this question is that VWs used as an alternative medium for learning lead to a change in perceptions of technology practices in the classroom and this increases the likelihood of their acceptance and adoption.

Although research in the field of pre-service teacher education is increasing, with particular attention and focus on technology practices, there are few studies that have taken into account the role of VWs in pre-service teacher education. Campbell (2009) focuses on the co-creation aspect in Second Life (SL), whilst Gregory et al. (2011), focus on increasing the pre-service teachers' confidence in their classroom management skills. Selvester (2012), on the other hand, focuses on gender roles in teaching and uses the VW to create a role reversal to enable changes in attitudes through role playing.

A gap in research exists about how the use of a social VW can affect the pre-service teachers' perceptions and attitudes towards learning technologies in the context of classroom teaching. This thesis aims to address that gap and contribute to knowledge

in how to best integrate VWs in the context of a pre-service teacher education program. The next section describes the design of the investigation.

1.2 THE INVESTIGATION

The investigation delves into the dynamics of how VWs used as an immersive medium can influence learning technology perceptions of pre-service teachers.

A study-unit entitled 'Integrating Learning Technologies' is adapted and redesigned as an immersive 3D VW experience called PreVieW (Pre-service teacher Virtual World). PreVieW was offered in 2012, as part of a 1-year teacher education program (post-graduate certificate in education - PGCE) at the Faculty of Education, University of Malta. It was followed by 111 pre-service teachers during a 13-week academic semester. Data was collected before, throughout and after this experience using three different methods (pre- and post- experience survey, small group interviews, and using VW data logs) and was presented in terms of the quantitative and qualitative findings relating to self-reported changes in their perceptions and self-belief towards technology practices as part of their classroom teaching. The triangulation of data has been used to reduce errors arising from each method applied, thus increasing the validity of the research and offering a more comprehensive exposition of the findings.

The results discussed in Chapter 5 indicate that PreVieW had an overall positive influence on the pre-service teachers' perceptions about learning technologies and their self-belief in how to apply them to their teaching.

The data generated by PreVieW revealed how the socio-collaborative learning models integrated in the VW design can contribute towards positive changes in perceptions and self-belief, in a way that can inform and support more effective real world classroom practices.

1.3 RESEARCHER ROLES

The interest of the researcher in this investigation stems from her background as an educator, and more recently as an academic involved in teacher education. The challenges presented are those that are most commonly seen as highlighted in this

recent era, where more classrooms have been fitted out with technologies and devices, but which have left teachers feeling stranded and at a loss on how to integrate them in their teaching. Various pre-service teachers have manifested anxiety at being forced to use technology in the classroom by the school administration. The use of VWs as media for learning is not a new endeavour but much of the research about VWs is limited its use outside formal curricula especially in higher education. The researcher was introduced to VWs in 2005, joining other educators inside the 3D space all working towards exploiting the platform for learning purposes. These experiences prompted the researcher to publish in the area of VWs as learning spaces.

The published research, coupled with the researcher's background and experience as an educator and teacher trainer, benefited the multiple roles taken on during the investigation. Although an element of bias and subjectivity might have been present due to the researcher's motivation and beliefs about education practices for the digital era, validity measures were set in place to ensure more objectivity in the collection and analysis of the data collected. The researcher's orientation during the investigation was driven by her motivation to learn more about how a VW could help teachers gain a different perspective on the learning technologies that they can use in their own teaching as applied to their specific subject areas.

The identification of the need for a framework in support of pre-service teacher education emerged as a result of the review of literature on technology acceptance and teacher education and by developing an understanding of the challenges in the area of VW research. For this reason, a multi-strategy design for the collection and analysis of data was chosen to present a more divergent view of the dynamics of the human-computer interaction in PreVieW. The pre- and post-test data were focused on changes in self-reported perceptions whilst the small group interviews were used to gain deeper insights into the perspectives of the participants about their 13-week experience. Log data gathered from the VW revealed the social connections formed by the participants during the experience.

Although the researcher was responsible for the planning and design of the VW learning space, the activities were designed so that the learners take on a more active involvement in their learning whilst the researcher could adopt a mentor/facilitator role, thus moving away from the traditional teacher-centred approach. A number of

information seminars were planned throughout the experience, each of which led and delivered by the participants. Most of the activities centred upon the completion of small tasks that were decided upon by members of the groups that were set up, and these were then discussed during open information seminars. Every week the participants were tasked with grouping up and assigning other groups questions, which they would then answer through the production of a virtual artefact and its presentation to the whole group during the seminars.

Although a number of VW-related guides as well as a number of presentations and documents related the various learning technologies were issued and published, the researcher didn't carry out any teacher-led sessions. The group roles and responsibilities were discussed and assigned within the group whilst the researcher could observe how the groups formed and worked together. This was done as a way to assign more responsibility to the participants for their learning, to increase peer and community practices and reduce as much as possible the subjectivity that may arise from the researcher's perspectives about the subject. Chapters 2 to 6 described in the next section, provide insights into the research issues related to this thesis and how the findings address the technology acceptance challenges faced by teachers.

1.4 Structure of the Thesis

This thesis is structured in the following way:

Chapter 2 provides the research rationale and an introduction to the research questions, hypotheses and the theoretical framework used in this investigation.

Chapter 3 provides a theoretical background and a review of the literature about technology acceptance and its role in education, with a specific focus on teachers and pre-service teacher education programs. The review also discusses VWs and why they are considered important as media for learning for the purpose of this investigation. This literature presents the characteristics and features of the VWs, which are attributed to their influence on user behaviour. Finally the literature chapter discusses some of the case studies where VWs are used in determinate educational settings.

Chapter 4 discusses the research methods and methodologies used in the investigation, as well as the tools used to collect data from the participant experience.

This chapter delves deeper into the design process of PreVieW, and how the development of the VW follows and integrates existent models.

Chapter 5 presents the findings under four headings emerging from the research questions discussed in Chapter 2. Each heading presents the findings in terms of the data collection method that was used, namely quantitative, qualitative and the VW logs. The findings are discussed as an interpretation to the answer of the main research question presented in Chapter 2. The inferences from the results are discussed in terms of the key factors, influences and roles of PreVieW in changing teacher perceptions, the social influences on learning in PreVieW and the role of social connections in the VW. The contribution of PreVieW is described in terms of proposed model as well as key propositions for the integration of VWs in a pre-service teacher education curriculum.

Chapter 6 concludes this thesis by giving recommendations for the application of the VW design in teacher education whilst proposing future studies in the application of VWs and pre-service teacher education.

1.5 Chapter Summary

Recent research has indicated the need for teachers to become empowered with skills to adapt their teaching to more learner-centric technology practices. However teachers find this adaptation challenging. Technology acceptance is one of the factors that plays a key role in changing current teaching practices. This chapter has introduced the hypothesis that using VWs as a medium for learning in a pre-service teacher education program will help pre-service teachers overcome this challenge by changing their perceptions and increase their self-belief in technology practices. The line of argumentation this thesis adopts is to model any positive changes in perceptions in the cohort, the level and extent of behavioural change and technology acceptance of the participants in PreVieW. The chapter which follows describes in more detail the research rationale, and the research questions stemming from the context of the problem.

CHAPTER 2

RESEARCH RATIONALE

2.0 INTRODUCTION

This chapter provides a rationale for this thesis by contextualising the challenges of technology acceptance and adoption in the classroom. Knowledge transfer for the use of technology-based tools is not considered to be enough to solve this problem. Solutions for this could reside in technology-driven learner-centric practices integrated in teacher education programs. Such learner-centred designed experiences arise as a reflection of the digital era practices characterised by technology-mediated social connections, co-creation and collaboration, as well as complex problem solving. In this thesis a 3D VW is the chosen technology providing the medium for social connection and collaborative practices on the basis of its immersive and social features. This is discussed further in Section 3.2 of this thesis.

This chapter presents the research questions that would help gain a deeper understanding of the human-computer interactions in 3D VWs when these are used as media for bringing about learning through changes in perceptions and attitudes. The answers to the research questions reveal insights about the influence of 3D VWs on perceptions, the factors and indicators that bring about such changes in perceptions, and the social connections that arise as a result of the learner-centred activities held in the VW. The research questions also inquire into the participants' thoughts and reflections about PreVieW to gain a deeper understanding of the human-computer interaction issues that affect the overall outcome. The final research question attempts to understand how self-reportedly, PreVieW has indeed influenced the participants' adoption of classroom learning technologies during their teaching practice. The hypotheses that follow provide a clear direction to the methodology than needs to be adopted when answering the research questions. The rest of the chapter discusses the thesis aims and objectives as well as outlines the possible assumptions and limitations of the research.

2.1 RESEARCH RATIONALE

An audience can either be receptive or resistant to change (Kassin et al., 2013). Research has shown that although there have been many advances in the uptake of information and communication technology applications and computer-mediated education, these are still being met with some resistance (Chan & Teo, 2007; Chang & Wang, 2008). A number of research studies have taken into account teachers' attitudes towards the adoption of various degrees of technology for teaching and learning (Liu, et al. 2010). Mokhtar (2005) reports that with the advent of more educational software, pervasively making its way into society, it is also expected that software, tools and applications also make their way into the classroom. Mokhtar (2005) presents the case whereby in light of the above, the teacher needs to be prepared not just technically in the use of digital tools, but also show a degree of acceptance and motivation for the increased use of digital resources for teaching and learning, which may sometimes extend beyond the classroom walls. This approach calls for a change in the way teachers and students interact with technology. One example of such a change would see the teacher shifting towards a *mentor* role, with the student taking on a more active and critical role, as the digital tools become the primary source of knowledge acquisition. This is the approach taken by the researcher in the context of PreVieW whereby she takes on the role of a mentor whilst the participants lead and present the outcomes from their peer assigned tasks. This is indicative of a constructivist approach to teaching and learning which places the student in charge of his/her own learning.

The paradigm shift placing technology as the medium for learning calls for changes in learning behavioural patterns within a specific context (Kirschner, 2002). Such changes may be facilitated and supported by integrating Wenger's (1999) communities of practice into the framework for a technology-mediated learning environment. Using communities of practice, the strength of the group emerges from the contributions given by each individual, whilst the behavioural changes of each individual arise from the collective achievements and sharing of expertise within the group. These studies support another paradigm shift in the way theory and practice become intertwined. Bandura (1985) discusses human behaviour and adaptation to change in terms of the self-regulation arising from a number of cognitive and self-

reflective processes within groups or communities of people. This whole process, together with environmental factors, can lead towards increased self-efficacy or rather the self-belief of the individual in adapting to change.

Most often these models have been investigated in face-to-face and blended learning modalities using online learning management systems. There is a gap in research in the theory-practice paradigm shift in the use of VWs in formal teacher education programs, especially in the use of an immersive environment as a medium to shift attitudes toward the use of learning technologies for teaching and learning. It is not yet known to which degree a 3D VW used as a learning medium may affect the attitudes and perceptions of the learners towards learning technologies and how they would change their classroom practice behaviour (Gregory at al., 2011).

The research problem in this thesis focuses on how VWs can be used as a medium to facilitate and support technology acceptance and adoption in classroom practice. In addition this thesis investigates how the design of a study unit that is part of the teacher education program at the University of Malta supported by technology-mediated social connections, collaboration and the co-creation of learning objects influences the learning experience. A 3D VW is adopted for the technological enhancement supporting the learner-centric practices described in the Connectivist theoretical framework (Siemens, 2004). The section that follows discusses in more detail the questions underlying this investigation with a reference to the body of literature to which they are bound.

2.2 Research Questions

The main research question (RQ) is:

> *How does the use of a 3D VW influence pre-service teachers' perceptions and behaviour towards adopting learning technologies for the classroom?*

The first hypothesis that is associated to answering this main research question states that:

H1: The VW experience contributes to a positive change in the participants' self-reported perceptions about learning technologies from their initial views.

Additionally the sub-research questions emerging from the main research question are:

Research question #1*: What factors and indicators show a positive influence on the participants' perceptions of learning technologies?*

An adaptation of the TAM instrument gives sufficient data resultant from the pre- and post- experience survey to identify which indicators contribute to the learners' self-reported change in perceptions. In addition to the correlation between the instrument indicators and the change in the learners' perceptions, this question also investigates additional factors, if present, that could affect the participants' views about learning technologies such as age, gender and specialised field of studies. The second hypothesis which will be tested is:

H 2: Contrary to personal perceptions, factors such as age, gender and field of studies have no significant effect on the participants' self-reported perceptions of learning technologies.

Research question #2*: Do the VW activities encourage more VW connections and interactions inside the VW?*

This question refers to the ways in which the learners manifest their behaviour through the connections formed and the interactions established inside the VW. Data logs collected in the VW are viewed as trails left by the learners as they traverse, explore and experience the VW.

This research question has associated with three hypotheses:

H3: Planned socio-collaborative learning activities inside the VW are positively related to increased participant interactions in PreVieW.

H4: In the VW there is a positive relationship between the users' chosen communication method and a reciprocation of the interaction.

H5: Increased text-based interaction amongst avatars contributes to a positive change in the perception towards the adoption of technology practices in the classroom.

Research question #3*: What are the pre-service teachers' reflections on learning in the VW setting?*

The participants' reactions, motivations, thoughts and views are collected using group interviews. The difference between the measure of attitudes and perceptions lies in the approach to the data collection. Whereas the surveys give a quantitative measure to the changes in attitudes, qualitative data methods are used to give deeper insights into how the perceptions of the learning modality change from the initial reactions to the final thoughts after the 13-week experience expires.

Research question #4*: How is the learning experience in the VW applied to the real world classroom practice?*

Jarmon et al. (2009) discuss various ways in which learning is transferred from the virtual to the real world, using the experiential dimension. However, this has not yet been explored in the context of teachers and practices for technology adoption. The context is different, because the problem does not relate to cognitive skills and content knowledge. Since this type of answer will typically arise from descriptive research, the group interviews together with excerpts from the researcher's reflections, would add insights into the VW learning experience.

2.3 HYPOTHESES

Research questions 1 and 2 discussed in the previous section use quantitative measures as well as SNA to determine the changes in perceptions that can be attributed to PreVieW and the connections established during the experience. Identifying the phenomenon and presenting evidence to prove it will help towards proposing a model for the integration of socio-collaborative VWs in pre-service teacher education. Each of the hypotheses outlined are discussed in more detail below.

Hypothesis 1: The VW experience contributes to a positive change in the participants' self-reported perceptions about learning technologies from their initial views.

This hypothesis is tested using results of the pre- and post-experience survey. The survey tool uses a 5-point Likert scale to measure perceptions about usability, ease of use, and behavioural intentions towards use of technologies in the classroom. The design of the VW uses a model which makes use of the learners' experiences, inducing activity and interactions inside the world, whilst giving opportunities for meta-reflection to extend from the VW to the real world.

Hypothesis 2: Contrary to personal perceptions, factors such as age, gender and field of studies have no significant effect on the participants' self-reported perceptions of learning technologies.

For a number of adult teacher trainees, the perceived sense of self and belonging in the community of teachers working with technology practices in the real world is dependent on variables such as age, gender and field of studies (Abbitt, 2011; Sutton, 2011). This affects the perception of their abilities and self-beliefs in relation to technology adoption in the classroom practice. The second hypothesis demonstrates that these factors do not have any significant effect on the attitude and the behavioural intention towards technology by relying on data collected from the pre- and post-experience survey. Annetta (2010) presupposes that identity embodied through avatars in VWs creates a sense of self and personal belonging within the VW that goes beyond physical and demographic factors that might impinge on self-beliefs.

Hypothesis 3: Socio-collaborative learning activities inside the VW are positively related to increased participant interactions.

The third hypothesis analyses the data mined from the VW platform in closer detail to determine the inter- and intra-group dynamics during the VW experience. The data collected from the VW are used to identify ways in which the communities of participants are formed. Wenger (1999) refers to communities of practice as groups of people engaged in a relationship, which can help them in the process of completing a particular task or activity. The approach described by this hypothesis takes into consideration the dynamics of both social VWs and serious games through the various elements it supports. This hypothesis predicts that the more activities are planned for the VW, the more the participants are likely to log in the world and be present as avatars, thus increasing the possibilities of extending their interactions for learning

that goes beyond simple content acquisition. This is especially visible when the participants meet to work together as groups.

Hypothesis 4: In the VW there is a positive relationship between the users' chosen communication method and a reciprocation of the interaction.

In the VW the interactions are measured in terms of the group text-based messages that are sent and received during PreVieW. This hypothesis states that for a given participant in PreVieW, there is a positive relationship between the number of text-based messages sent and received; the more text-based messages a participant sends, the more messages he/she would receive. This would increase the likelihood of the participants establishing more communities of practice inside the VW. With more communities, the likelihood of a positive self-belief increases as well (Wenger, 1999).

Hypothesis 5: Increased text-based interaction amongst avatars contributes to a positive change in the perception towards the adoption of technology practices in the classroom.

This hypothesis uses data logs mined from the VW to map the extent of the influence of the participants' social connections in relation to their changes in perceptions. It is being hypothesised that the greater the number of text-based interactions, the more likely it is that the participants' responses would demonstrate a positive change in their perceptions.

2.4 Scope and Outcomes

Although learning can be accidental, it does not happen by accident. Design for learning is also about creating the right conditions whereby accidental connections can be made. The motivation to study this relation between perceptions and behaviours and the use of VWs as a learning medium arises from the technology adoption challenge present in teacher education. This research investigates the effects of a social 3D VW, designed using an exploratory framework model, on pre-service teachers' perceptions about classroom technologies. The contribution of this thesis is in the form of a new model for the integration of a socio-collaborative VW in pre-service teacher education.

At the end of this investigation the outcomes will include:

- a measure of the participants' attitudes and perceptions about learning technologies given by the data collected from the pre- post-experience surveys emerging from the pre- and post- experience survey results;
- a visual representation of the social interactions between the learners inside the VW as well as a measure of the correlation between participant interactions, collected from the VW data logs, and the changes in attitude shown by the results of the pre- and post-experience survey;
- an analysis of the main themes emerging from a number of post-experience focus group interviews;
- a contribution to the growing body of research on educational models for VWs with the presentation of a connective learning model of PreVieW, and practical applications for the integration of VWs in Teacher Education Programmes.

2.5 Delimitations and Assumptions

The assumptions for this research target two important building blocks of this research investigation, which will focus on the 'who' will be affected and 'what' will be presented in the results emergent from the objectives.

Assumption 1: Target groups of users are pre-service teachers who do not have prior experience inside VWs.

This research will assume that the participants will be higher education students enrolled at the University of Malta, reading for a Post Graduate Certificate in Education (PGCE). This means that these students will eventually practise the teaching profession in secondary schools in Malta. Based on previous PGCE groups, it is assumed that the students have no previous experience inside 3D VWs. It is also assumed that the students do not have any learning experiences in 3D spaces.

Assumption 2: Target groups of users have limited or no previous experience in the application of learner-centred innovative classroom learning technologies.

This assumption finds its basis in a discussion by Sang et al. (2010), who argue that despite the fact that ICT integration within the classroom setting has shown potential for the development of pedagogical implications, technology acceptance and uptake by teachers is still a major challenge which needs to be overcome. The authors also discuss how the integration of technology use and teacher uptake is heavily dependent on a number of parameters, which include cultural factors, gender issues as well as teacher thinking beliefs. In their studies they focus on 'student teachers' going through a pre-service training on how to adopt technology and use of computers in the classroom. Research shows that despite regression of barriers leading to adoption of technology in the classroom setting, teachers still show despondent behaviour when adopting technology practices. Sang, et al., (2010) in their studies implied that teacher training course content (delivery and approach) does facilitate use within the classroom during in-service teaching.

The National ICT Strategy for Malta 2008-2010 (2008) has indicated a number of investments in the ICT sector, integrating society, business and education in one strategy for Malta. This fits the assumption put forward for this research, as it brings together previous work held in the area, discussing the teacher preparation impact on the facilitation of technology acceptance for classroom practice. It is also in line with the proposed ICT strategy for Malta (2008), which implies teacher preparation in the adoption of technology practices.

Assumption 3: The proposed content is in line with the teacher education curriculum objectives of the Faculty of Education, University of Malta.

The third assumption proposes that content inside the 3D VW developed is in line with one of the study-units being delivered at the Faculty of Education. The core content offered is based upon a number of themes:

- eLearning
- Virtual Learning Environments

- Open Education Resources
- Social Networks for Learning

The content proposed for the experiment will use the same vision of the program, and will focus upon the use of learning technologies for the 21st century classroom.

2.5.1 RESEARCH LIMITATIONS

Four delimitations of this research have been identified:

a) The first delimitation is in the number of participants in the research. Although a whole cohort of the PGCE group is targeted, their participation is subject to their willingness to partake in the experiment. This might limit the number of responses and participation in the experiment. The number is also dependent on how many students enrol in the PGCE program of studies during the year 2012/2013.
b) The second delimitation arises from the students' experiences outside the specific study unit in the teacher education program, as well as their life outside campus experiences. Since PreVieW is not conducted in isolation but as part of a holistic curricular setting in teacher education, there are possibilities of instances that might have an effect on the participants' attitudes in relation to the acceptance and adoption of learning technologies for classroom practices. This effect might be conducive to positive or negative changes in attitudes and this can, in turn, have an effect on the responses given by the participants.
c) The third delimitation lies in the VW platform chosen. User friendliness, or perceived lack of, as well as its capability to handle more than 111 participants at one go can have an effect on the participants' perceptions of the VW experience, decreasing their likelihood of extending their presence and participation in the world.
d) A final limitation of the investigation lies in the multiple roles assumed by the researcher. Due to resource availability and logistical restrictions, the researcher had to assume responsibility for the design and development of the content as well as the planned activities in the VW, the coordination and

development of the study-unit in the PGCE program of studies, as well as the data collection and analysis.

In an attempt to counteract these delimitations, which can lead to an increased error in the analysis and interpretation of the results, a triangulation method is proposed to collect data. Multiple sources, which carry their own errors and limitations can thus increase the objectivity of the results and decrease the overall error in the conclusions that might be drawn. In addition to this, a number of additional strategies on the handling of the researcher multiple roles are proposed in Chapter 4 and their application discussed in Chapter 6 of this thesis.

This research, additionally, does not attempt to make predictions on the cultural and gender perceptions that might affect technology practices in the classroom. It does not evaluate the content made use of in the VW, nor does it attempt to give a measure to the cognitive skills attained during the course of this research.

2.6 Chapter Summary

This chapter has presented the rationale for the need of a different approach to increase technology acceptance and adoption by teachers. VWs were chosen as the approach to support and facilitate technology acceptance. The research questions enquire how VWs can be used as a medium to affect user behaviour, what key factors impinge on the outcomes, and how the pre-service teachers perceive learning technologies as a result of their PreVieW experience. The chapter which follows presents the literature surrounding classroom learning technologies highlighting the need for teachers to accept and adopt them. Chapter 3 also reviews the features and characteristics of VWs and presents the lessons learned from case studies involving the use of VWs for learning.

CHAPTER 3

LITERATURE REVIEW:

TECHNOLOGY ACCEPTANCE & VWS

3.0 INTRODUCTION

This chapter follows up on the rationale from the previous chapter, by contextualising a current challenge in teacher education and discussing the academic research that is being undertaken to help find a solution to overcome this challenge. The first part of this chapter offers an understanding of the framing of classroom learning technologies for the purpose of this thesis. Although there is much research going on in the area of classroom based technologies the understanding in this thesis is that attitudes provide the foundation for adopting effective digital practices. The first part of this chapter discusses the various models that are being adopted in teacher education, and provides a rationale for the choice of one model that would best provide answers to the research questions posed in Chapter 2. The second part of this chapter discusses the rationale for choosing 3D VWs as the technology supporting user-centric practices in an immersive environment. The characteristics and features of VWs that facilitate changes in user behaviour are also discussed in further detail. The final part of this chapter discusses a number of case studies and best practices of VWs in higher education and more specifically in teacher education leading to a number of factors to be taken into consideration for the design and development of PreVieW.

3.1 CLASSROOM LEARNING TECHNOLOGIES – ATTITUDES AND ADOPTION

As discussed in Chapter 2, the needs reflecting a change in teachers' roles and skills, arise from the needs of the digital society. Jose' Manuel Barroso in his address in the Europe 2020 strategy, describes one of the priorities as being "Smart Growth: developing an economy based on knowledge and innovation" (2010). This priority addresses education from the perspective of learners who value quality in education, and who develop their cognitive potential in a way which can benefit society from an

economic and market perspective. A more knowledgeable society implies a more educated workforce that is capable of generating innovative ideas in the creation of products and solutions of problems that afflict our society. Redecker et al. (2010) predict that between 2020 and 2030, although standardised degrees and testing will still be present, the teaching and learning strategies will incorporate more flexible and personalised approaches. These approaches can be facilitated and supported by the use of technology and digital practices. The report, in addition, proposes that the role of teachers will need to shift to one which pertains to a mentor/guide for the learners throughout their growth. The implication is that teachers need to adapt actively to the various challenges posed by society's needs requiring increasingly differing skills and competences. Boltanski and Chiapello (2007) refer to this as the "streamlined self" or rather the individual whose achieved skills can empower him/her with enough flexibility to adapt to the change which characterises this "new spirit of capitalism". According to the authors, the effect of having a technology-driven society can lead individuals towards a greater sense of insecurity and overall tendency to disruptiveness, unless those same individuals embrace and adapt to change.

Authors like Ken Robinson (2001), Seely Brown (2006) and Jenkins (2006a.) describe how the individuals making up a dynamic society are promoters and creators of ideas. All these authors recognise the need of adequately preparing the individual members of society to adapt to the changes which have characterised this century, as the problems afflicting the world we live in require solutions which go beyond the trademark characteristics of having someone lead while all the rest follow. As a specific example, one can discuss the impact of social media. With so many people making use of online networks facilitated by social media, they need to be equipped with the right set of digital skills that would empower them to critically cope with the masses of information that they are exposed to (Van Dijk & Van Deursen, 2014). Such skills, according to the authors would include operational skills (operating a device), formal skills (working with tools and applications), information skills (filtering information) communication skills (best practice in digital and online communication), content creation skills (generating content) and strategic skills (problem solving using the digital or online medium).

With the pressing needs of so many world problems in need of a solution, society needs individuals who are capable of making reasoned arguments, building towards

practical and creative solutions. On the other hand the education system which is common to a great number of countries does not foster this kind of thinking, but produces individuals paradoxically spurned as 20th century factory workers, requiring little or no initiative and repeating mechanically actions and behaviours inculcated into their psyche (Robinson, 2001). Gilbert (2011) discusses how the role of today's teachers needs to change to reflect the needs of the digital society. In his book, he sees teachers as enablers of knowledge for the 21st century learners who are connected to the digital world placing emphasis on information handling, communication, content creation and strategic skills to help them grow professionally as discussed by Van Dijk and Van Deursen (2014).

In this context, this thesis takes into consideration how the teachers' classroom attitudes should focus more on skills related to communication, adaptation and problem-solving strategies to reflect the 21st century practices rather than skills related to content transfer. This means that the design model will focus on guiding students to learn how to learn in the digital era, rather than learn how to operate a specific device or work with set applications. Acquisition of these skills is also influenced by self-efficacy in digital practices that would empower teachers to switch between the roles of consumers as well as producers of digital resources. This would require competences that go beyond cognition of technologies and devices, extending to attitudes towards adaptation and change. This notion frames the understanding for classroom learning technologies as discussed in the sub-section that follows.

3.1.1 A Framing of Classroom Learning Technologies

The transformative power of technologies for learning has been discussed at length by a number of educational theorists including Seymour Papert (1998). This places the use of technologies for learning by teachers as more than just the use of applications for office or administration purposes. Chen (2010) describes the use of this type of technology application for learning as one which supports student-centred learning, rather than reserving the use of technology for lesson and resource preparation.

In a recent study, Polly et al. (2010) echo their preoccupations and those of a number of educational institutions involved in the preparation of pre-service teachers and committed to providing basic skills in the educational technologies with the intent of

promoting more technology use in todays' classrooms, about how to provide good technology training. However, as the study implies, many educational researchers are finding that basic skills in technology applications are not enough to be able to adopt technology in the classroom. Sutton (2011) agrees with this, and identifies three major themes which also seem to be recurring in the findings by Polly et al. (2010). The issues which seem to hinder the adoption of learning technologies to provide for a more student-centred environment include the disconnection between educational technology courses and content methodology courses, a lack of identification of the relevance between the content area and how technology can be applied and a challenge for education institutions to develop more learner-centred approaches towards courses in teacher training programs.

The issue of what technology content should be within teacher training courses to help them adopt a more learner-centred approach in the classroom, is a growing issue of concern (Chen 2010). However Buckingham (2007) frames the use of technologies for learning as going beyond the classroom context and more into the popular culture. According to him, technology use is more about providing authentic learner experiences for the student inside and outside the classroom. Klopfer, Osterweil, & Salen (2009) place the challenge in today's classroom, as teachers who need an engaged audience and learners that need to be as engaged in the class as they can be outside the class. Such engagement, they argue can be brought about by the use of different technologies for learning that might include digital gaming, simulations and social networking.

In this thesis learning technologies are not limited to digital games, VWs and simulations, and social networking. However it is understood that the use of learning technologies for teaching can extend from VWs and digital games to any media, including digital media, as well as communication and collaboration technologies, that would provide for a more interactive, engaging and learner-centred classroom. This is in agreement with the stance taken by the Connectivism theory which professes a new theory for the Digital Age. According to Siemens (2004) and Downes (2008), learning in the digital age is the result of diverse opinions and interactions coming together through the online medium, where each individual contributes to knowledge in one form or another. Knowledge is seen as a process of creation as well as consumption, thus in framing learning technologies for the classroom, this

investigation assumes that the pre-service teachers display their pre-disposition to adopting learning technologies by contributing to knowledge content through the creation of different learning objects, integrated in the 3D VW. However the creation of learning objects is not considered to provide a deep enough insight into how the 3D environment would influence the pre-service teachers' perceptions and behaviour towards such classroom learning technologies. The following section discusses alternative methods of measuring teachers' attitudes towards learning technologies.

3.1.2 Learning Technologies in Teacher Training

Recent studies by Alharbi (2013) and Shirvani (2014) discuss how technology use and adoption by teachers is not just affected by barriers such as limited resources and lack of proper infrastructure supporting use of technologies for class learning. Both claim that the teachers' internalisation of technologies is largely affected by their self-beliefs, confidence in the use of and attitudes towards the perceived usability of such technologies for their teaching. Additionally the findings from Alharbi posit that teachers require training and support to be able acquire more confidence in the use of learning technologies in the classroom. However the study by Alharbi does not describe the type and approach that such training could take.

Kirschner and Davis (2003) argue that teaching about ICT tools is not sufficient for the 21st century education paradigm. The teachers need to change the way they think by internalising the technology as part of their everyday practice. Just as they unwittingly make use of social media platforms, such as Facebook, to communicate their status updates or share their thoughts, so would they be able to adopt digital practices in the classroom. Studies by Sutton (2011) about teachers' perceptions of what a technology training course should consist of, indicate that they feel that this should not be disconnected from their other teacher training courses. According to the teachers interviewed by Sutton (2011), their needs focused around the opportunity to plan for student-centric technology rich lessons, to reflect on their digital practices and the new digital skills they were introduced to during their pre-service teacher training program. Sutton's conclusions are that teachers need authentic learning experiences to be able to internalise technologies which they would then be able to adapt to their own teaching practices. The implications for teacher training in technology are also echoed by Shirvani (2014) whose studies indicated that people

with a greater exposure to technology would generally show a more positive attitude towards using learning technologies in the classroom.

Chen's study (2010) investigates the factors which may affect the teachers' future adoption of a more innovative use of technology in the classroom. His study concludes that although training and support are very important factors in the teachers' motivation to adopt technology practices, there might be additional factors that would influence their behavioural intentions to change their traditional practices. Such factors may indicate that the teachers' beliefs and perceptions as well as the social context which they inhabit can indeed have an influence on their behaviour in class.

An analysis of the local scene shows that although Maltese teachers seem to have necessary support and training to support good technology practices in the classroom, they are still not adopting such practices (Pullicino, 2012). Although this has been attributed to the physical resources and school infrastructure in some cases, this analysis indicates that the barriers to the uptake of technology practices may run deeper than formal training in the use of tools, support or availability of resources. This resonates with Chen's (2010) conclusions and seems to indicate that factors involving social structures and community connections may impinge on the teachers' attitudes towards technology practices. Two models that are most frequently associated with the integration of learning technologies in pre-service teacher education have been identified and are discussed in the section below.

3.1.3 Models Investigating Technology Acceptance and Adoption by Teachers

This section will review the two main models that have been investigated at length for assessing and integrating technology programs in pre-service teacher education. The first model – Technology Acceptance Model (TAM) has initially been proposed for the integration of technology at the workplace (Davis, 1993) but has subsequently been adopted for pre-service teacher education, whilst the second offers a framework for the integration of technology based on a model first proposed by Shulman (1986), as Pedagogy, Content, Knowledge (PACK) and which was later adapted by Mishra and Koehler (2006) as Technology, Pedagogy, Content, Knowledge (TPACK).

3.1.3.1 TECHNOLOGY ACCEPTANCE MODEL (TAM)

Throughout the years there have been many attempts at understanding more about the factors that may affect the teachers' attitudes towards technology-based classroom practices.

The Technology Acceptance Model that was initially proposed by Davis (1993), shown in Figure 1 below, was meant to measure the level of and predict the users' behavioural intention to adopt technology at the workplace. It uses two main determinants related to computer usage: the perceived ease of use (PEOU) – "degree to which a person believes that using a particular system would be free of effort" and perceived usefulness (PU) – "degree to which a person believes that using a particular system would enhance his or her performance".

Figure 1 - Technology acceptance model (Davis, 1993)

This initial model reflected the different digital practices current at the time when operational and functional skills) were essential for an individual to perform computer-related tasks. Operational and functional skills relate to the way the users operate and use the computer as a device to carry out specific tasks (Dijk, J, & van Deursen, 2014). The scope of the model was to determine the factors that would influence technology acceptance and the ensuing adoption at the workplace. This initially didn't include formal teaching institutions. Subsequently, other researchers developed the TAM to adapt it to changing digital landscape across industry to predict behavioural intention and usage (Hossain & de Silva (2009)). These studies concluded that there may be additional factors to Davis's initial propositions that PEOU and PU may be the sole factors influencing the behavioural intentions to adopt different technology practices.

More than a decade later authors Chan and Teo (2007) investigated the effects of PU and PEOU over the Behavioural Intention (BI) to use a specific technology. Their studies indicate that the combined interaction values from the two variables lead to a greater probability of BI to use the technology. Their studies also claim that whilst PU may compensate for a low PEOU value thus increasing the predictability of increased BI, a low PU will not be compensated by a higher PEOU value. The authors present results which are indicative of the situations when it is best to concentrate on PU rather than PEOU and vice versa, giving the best BI in the specific context. Previous research had been based on empirical studies, thus giving the overall impression that strength of PU and PEOU were consistently adopted throughout their whole space of application, but results from Chan and Teo (2007) indicate otherwise. In this regard, the findings show that when users perceive the technology to be of use and can enhance their job performance, this becomes an important factor in the prediction level of the behavioural intention of that user to use the technology provided. However more studies emerged from these findings, reflecting the changes in technologies and the intersections between working and learning, both at the formal, non-formal and informal learning levels. Hossain & de Silva (2009) explored an additional factor which in their opinion could have an influence on the TAM model and which can be seen throughout the increasing growth of virtual communities. This factor looks at the social ties that are developed within the virtual community. In their study the authors use social network theories to understand how the social influences impinge on the users' attitudes towards technology acceptance and adoption. This model's framework is designed around concepts of behavioural modelling for use of technology-based applications via digitally mediated group communication. Their studies integrate TAM with theories emergent from the fields of sociology and social network research and their findings suggest that the social ties within the virtual communities play an important role in the influence over users' attitudes and behaviours. The study suggests that the social ties between users in a virtual community may impinge on the constructs first proposed by Davis, but it still doesn't explain how. The authors propose that future studies would gather more information through users' perceptions about the propotypes or functional systems' to further ascertain whether the users would be using the technology in the future.

The research discussed above seems to indicate that aside from taking into consideration the social context as a possible variable that may have an influence on the users' acceptance of technology, one has to consider different ways of gathering the information from the users that would also ultimately give an indication of the causality between the variables.

In 2009, a number of researchers started investigating the uptake and usage of the technology applications by pre-service teachers within a classroom environment. In their studies the researchers applied the TAM to predict the future adoption of technology in the classrooms (Teo, 2009; Sang, et al., 2010; Chen, 2010).

Teo (2009) discusses how the TAM, as shown in Figure 1, might not be fully suited for the education paradigm due to the external variables which mediate the perceived usefulness (PU) and perceived ease of use (PEOU). The author investigates how according to the theory of reasoned action, PU, attitude and computer self-efficacy are fundamental determinants in computer user behaviour, whilst PEOU and the technology complexity may affect behavioural intention (BI) to use directly. Therefore, for the author added variables in addition to those proposed by the TAM are fundamental in the uptake of technology use by pre-service teachers. This resonates with the discussions above that one has to take into considerations the context in which the teachers work, and the social interactions which are fundamental to their line of work.

Chen (2010) discusses how most of the research in TAM as applied to education takes into account technology use for "informative" (such as Internet use), "expressive" (such as word processing) and "administrative" (such as lesson planning) use. The author investigates a gap in research which attempts to indicate not just the behavioural intention to use technology in education by teachers, but also aims to answer the question of how these teachers would be using technology for student-centred learning. The proposed model constructed by Chen, illustrates how measurement of variables will give descriptive results, showing pre-service teachers' use of technology for student-centred learning.

Figure 2 - Proposed theoretical model for measuring variables indicating pre-service teachers' use of technology for student-centred learning (Chen, 2010)

The model shown in Figure 2 uses the SEM statistical analysis, testing causal cycles of dependent and independent variables. A number of indicators were set for each variable to support correlation models and data. The studies take into account intrinsic and extrinsic variables for pre-service teachers and seem to indicate that teacher training during the pre-service period augments self-efficacy whereas context and training gave a high correlation. The results obtained imply a gap in the research which analyses the efficacy of teacher training, mediating technology use and behavioural intention. This gap takes into account the practical and contextual environment in which teachers would be using the technology. Cuban (as cited in Chen, 2010, p.41) proposes another latent variable – "the situationally constrained choice" – which can also be particularly suited to the SEM analysis and which would address the contextual nature of the teachers' decision to use technology within the classroom setting and for specific student-centred learning.

Even though the TAM model has been adopted, adapted and revisited, studies outlining complex external factors, such as social interactions and community relationships and how these affect the model, are quite limited. Another gap in research is the investigation of the effectiveness and predictable value of TAM for games and simulations.

3.1.3.2 TECHNOLOGY PEDAGOGY CONTENT KNOWLEDGE MODEL (TPACK)

Mishra and Koehler's (2006) model arises from Schulman's theoretical framework, which has been adapted and adopted widely in teacher education, for framing the overlap of and intersections between pedagogy, content and knowledge. However the authors suggest that teaching in today's world is a much more complex endeavour, owing much of this complexity to the permeating classroom technologies.

Figure 3 – Pedagogical Technological Content Knowledge by Mishra & Koehler (2006, p. 1025)

The model in Figure 3 is intended to show that various interplay of factors that affect teacher education from a holistic perspective. In this model, there is an integration of the knowledge of technology practices, the pedagogical concepts driving teaching through technology whilst addressing ways of how technology can help teach different concepts that might be difficult to teach otherwise. However this model does not address the more social aspects of technology that are more prominent in today's digital era.

Moreover the authors, Koehler, Mishra & Yahya (2007) at a later stage use a learning design process using a constructivist approach to understand the connections between the knowledge pedagogy, content and technology set in an authentic setting. In their study, the authors frame a 15-week learning design technology seminar, during which the participants contribute to the design of an online course, conclude that with increasing time, and set within a practical context that is authentically grounded in a real problem setting, the participants' discourse evolves to highlight the relationships

and intersections making up TPACK. Their approach offers a greater insight into the methodologies for integrating research theory and practice, by making use of discourse analysis to identify the extent of discussions in a more focused context.

Abbitt (2011) has carried out a review of a number of studies related to the application of TPACK to pre-service teacher education. In his review he makes a distinction between self-reported and performance-based assessment measures for TPACK to gauge teachers' knowledge about technology.

Figure 4 – Model emergent from a review of existing TPACK methods and instruments for measuring level of teacher technology knowledge (Abbitt, 2011, p. 296)

Figure 4, shows the different number of methods and instruments that researchers are using to gauge the level of knowledge of technology in pre-service and in-service teachers. He makes a distinction between self-reported measurements and performance-based rubrics to gain information about the learner's level of technology acceptance. According to Abbitt, although there are a number of instruments and measures in place that would be able to give a measure of the participants level of knowledge of technology as applied to content and pedagogy, there are still gaps in research that would need to be addressed. One such gap would be the model's predictive ability of the teachers' future adoption of technologies in the classroom.

Another identified gap concerning the TPACK model, are the social interactions and how these would impinge on the model, or how they would fit within the model presented. Since it has been argued and agreed that teaching is a largely complex exercise that is influenced by a number of factors that are emergent in different

classroom contexts, it is felt that TPACK does not address the social interactions, that would result and take place in a school or learning setting.

In another study using the TPACK model, Sutton (2011), expands on the concept of an authentic learning experience during pre-service education to investigate the connections between knowledge, content and how technology can be applied in the context of a classroom. In this study, the author analysed the training experience of newly qualified teachers in relation to the technology program during their teacher education program. The findings emergent from the investigation suggested that the newly qualified teachers felt there wasn't a clear connection between their subject content and the technology program. This tallies with findings from Mishra & Koehler (2006) which emphasise the need for the connection between technology, content and pedagogy. Similarly the respondents felt that there was a lack of relevance between the technology program and what they were learning to teach. The author's study revealed that pre-service teachers felt that many of their mentors were not practicing the value of technology in a way which went beyond the basic applications such as the use of PowerPoint during lectures, online documents and emails. The final finding showed that the participants felt that they were not using much of what they covered during their teacher education program, either because they forgot or because they didn't understand how they could use it in the first place. The implications from Sutton's findings, reflect many of the researchers that have been investigating teachers' acceptance and adoption of classroom technologies, in that the teacher education program should provide authentic learning experiences, that the technology needs to be related to the subject area which the teachers would teach and that there are more opportunities for the teachers to reflect on the relevance of what they are learning in terms of technology practices.

This was also mentioned in another study by Kumar & Vigil (2011) who proposed reflection as another consideration for design of pre-service education modules. This reflection comes through as the critical analysis and evaluation of tools, technologies and media that can be adequately adopted to the content of the different subject matter that teachers teach. Many respondents in the study carried out mentioned the lack of adequate hands-on skills that are needed for increased confidence in not only using technology but also coming up with creative and innovative ways of how technology can be integrated into education.

However TPACK and TAM were not the only models that have been investigated in relation to pre-service teacher education. Other models have built upon the existent TAM model, whilst some have proposed entirely different perspectives of how technology can be integrated, and how its acceptance can be measured in the different contexts.

3.1.3.3 Other Models Used for the Adoption of Technology

In one such study, Sang et al. (2010) look at technology acceptance from the perspective of why teachers lack the enthusiasm' to implement classroom learning technologies (Figure 5).

Figure 5 - Integrated model of the impact of gender and student teacher thinking processes on prospective classroom ICT use (Sang, Valcke, van Braak, & Tondeur, 2010, p. 105)

Although the study was primarily conducted amongst Chinese participants, certain coherent results with Western cultures could be observed. The results show that within the right environmental setting, teachers' attitudes and perceptions towards computers and their uptake within the classroom change in such a way that they become more open towards technology adoption.

This study by Sang et al. also gives an indication that for a successful integration of technology programs within teacher training courses at higher education, there needs to be a degree of reflection that would be based on the teachers' social interactions within the classroom setting.

Other models build upon the notions of continued use of technology, such as the Post-Acceptance Model (PAM) and the concept that for technology to be continuously

made use of in an effective manner, it should also be directly related to work (Larsen, Sørebø, & Sørebø, 2009). In this case, the issue of self-efficacy is also very much present, as an individual's heightened satisfaction is also the product of the outcomes of such use of technology.

Further research by Magni, Taylor, and Venkatesh (2010) proposes the use of the time factor as one of the variables moderating the behavioural intention (Figure 6). Thus users need more time to acquire more confidence in the use of the technology by exploring it and through reflection lead to a more innovative use of that technology. However the authors also stress the importance of the technology to satisfy the users' utilitarian and hedonic needs.

Figure 6 – The research model proposed by Magni, Taylor, & Venkatesh (2010, p. 573)

The authors' model (Figure 6) proposes hedonic factors as well as performance expectancy and image enhancement, as additional important factors that over time can contribute solidly to the users' intention to adopt specific technologies. In their suppositions, the authors extend technology acceptance to fit in an exploration theory, positing that users who display intrinsic and extrinsic motivation toward the technology have the increased tendency of exploring the technology, thus taking the technology beyond usage and more towards learning at a deeper level. This implies adoption of the technology as part of a greater, more profound learning experience. The authors include time as a moderator of the "Exploration" model, where the individual performance in technology-based application shows a variance over time, thus establishing a definite relationship between the intention to use, the intention to explore and the time factor. The authors build upon the previous TAM research extending the technology acceptance to technology exploration, thus providing the

grounding which necessitates the design of technology which provokes individuals to explore rather than simply adopt the technology being presented.

Although this study in itself does not involve pre-service teacher education as its target user groups, its findings are also quite interesting when applied to the teaching context. The conclusion that having a more ubiquitous access to the technology increases the possibility of adoption, and possibly a more innovative use of the technology would give an indication, that for the pre-service teacher education course, technology needs to frame the target users' program period, in a way that they would have access to it, whenever and wherever it is more convenient. Thus traditional ways of teaching users about technology during specific and allocated time periods might not lead to the successful adoption of technology in the longer time frame. The indications from this study are that use of immersive technologies might appeal more to the users contributing to increasing the hedonistic and instrumental factors thus affecting classroom learning technology acceptance and adoption.

3.1.4 A Critique of Models for Technology Adoption in the Digital Era

This sub-section analyses the different models discussed above from the perspective of learning in the digital era and will justify the use of one of these models for understanding more about the behavioural intentions to adopt classroom learning technologies when the medium for learning features a 3D virtual world.

As of the date of publication of this thesis, the Faculty of Education at the University of Malta has still not published its digital strategy and the digital standard competences for teachers. For this purpose a number of references in this thesis direct to UK-based sources.

Education, as stated in section 3.1.1., places emphasis on learner-centric theories rather than simple use of technology-based applications. These theories are inspired by a number of influential models of learning such as Vygotsky's social learning model (1997), placing learning as an activity which centres around the individual's change in behaviour patterns as a result of the different interactive processes within a given context. Models showing the cycle of learning, such as Kolb's experiential learning cycle (1985) focus upon the generation of new knowledge content based

upon observation and reflection. In a parallel model, Dewey's learning cycle is based upon problem solving and reflection. These two models, when merged with social learning models such as Vygotsky's sociocultural theories, or Wenger's communities of practice (1999) produce a knowledge cycle that includes experiential learning, reflection, and social collaboration.

A report published by the Open University on Innovating Pedagogies (2014), places emphasis on networking with clear implications on a pedagogy that is mostly learner-driven and learner-centric. This report discusses practices, which amongst others make use of analytics to determine, model, and monitor learning online, as well as offer alternative approaches to assessment that places as much emphasis on assessment as well as the intervention arising from the practice. Another important consideration in the report is given to learning how to learn, in terms of the self-determination theory. In this aspect, learners show an intrinsic motivation driving their learning through connections and the networks they set up. This report then provides insights into some essential elements characteristics of learning in today's digital era. Learning today is seen as being:

1. Learner-centric
2. Learner-driven
3. Connected
4. Social & Communal
5. Informed by the learner's online behaviour.

Both the Open University (Peachey, et al., 2010) and the University of Edinburgh[1], have embarked on using VWs as media supporting course delivery and student interaction. Both projects make use of a learner-centric approach driven by community practices. Use of social computing and new learning technologies that facilitate a more interactive way of processing knowledge seems to be paving the way for future directions in higher education (Perera, et al., 2010). This past decade has in fact seen the growing rise of online learning (Bonk, 2011) with a culmination into extreme forms of learning such as the MOOCs adopted by Stanford, amongst a

[1] University of Edinburgh were among the first pioneers when in 2007, in establishing a virtual University using Second Life as a platform, and effectively delivering courses inside the virtual world. Available Online: http://vue.ed.ac.uk/ [Last Accessed: March 2012]

growing number of other higher education institutions, with reported and projected participations that have risen beyond expectations (Pappano, 2012). A number of research studies have also investigated the growing notions of personalising learning by adapting technologies to be able to provide the learner with an online personalised path for his/her set learning outcomes on the basis of information supplied by the learner portfolio (Vargas-Vera & Lytras, 2008). This concept of personalised learning is not new, arising as a response to challenges in online learning defined from the reported sense of isolation that learners manifest in the online environment (Weller, 2007). All these developments share one common driver – the creation of an environment leading to a more effective learner engagement.

These then become central factors when considering which model to best adopt and adapt to determine the probable behavioural intentions of teachers to take on best technology practices. Although many of these characteristics are not novel, with a number of learning theories supporting each of them individually, there is a gap in research in their combination as external factors driving technology acceptance

Findings by Burton Jones & Hubona (2005), which make use of Davis's original TAM model, give strong indications that the learners' individual differences are key variables. This implies a consideration of aspects that take into account the complexity of the ties and interactions which affect usage and behavioural intention to use. This is also in agreement with Chen (2010) and Teo's (2009) arguments that the TAM has to be enriched with additional variable signatures. Burton Jones & Hubona (2005) furthermore argue that the two variables PU and PEOU on their own do not fully mediate the effects of the individual differences which took into account age, education and seniority within a working organisation. However even they fail to mention the community effect and how this may impinge on the user's level of technology acceptance and adoption. This further strengthens the need for the consideration of additional variables when using this model to predict the behavioural intention to make use of technology practices. Therefore, when one considers the TAM as a model, one has to take into consideration the use of technology by educators for learner-centric facilitation during classroom sessions rather than simply the use of technology for lesson preparation.

The TPACK model on the other hand, considers the integration of technology into a teacher education program from a holistic perspective. This means that according to the TPACK model technology adoption will have more likelihood of success if the knowledge of technology overlaps and intersects both the teaching subject content, as well as the subject pedagogy, over the entire teaching program. Although this is an interesting concept to adopt at a higher education program of studies level, it would still not provide an answer to the question of how a 3D immersive medium would be able to impact on the user's acceptance of learning technologies.

In this thesis a 3D VW is integrated in a study-unit delivered as part of the formal teacher education curriculum in an attempt to understand how an alternative modality for learning can modify pre-service teachers' perceptions towards learning technologies. For this purpose, rather than the adoption of the TPACK model as a holistic approach for a teacher education program, an adaptation of the TAM model is used to ascertain the difference in attitudes before and after the VW experience. A similar experiment discussed by Hossain & de Silva (2009) using TAM to measure the influence of social ties in a virtual community, seems to come the closest to fulfilling the needs of this investigation and answering the research question. Their investigation aims to validate the TAM in the context of virtual communities, whilst determining the influence of social ties as factors influencing users' attitudes towards technology. What emerges from their research, is that social ties do indeed have influence on users' attitudes, but that by collecting and analysing the users' perceptions in addition to the changes in attitudes, may give a more comprehensive view of whether they would ultimately accept the technology under study. Although Hossain & de Silva, investigate a virtual community website, the findings show that the TAM model can be applied to virtual environment systems. However extended constructs to the model should, according to the authors, take into account the connections happening between the participants in a virtual community. These connections can be manifested through the online social networks that are formed. In this regard this thesis takes into account a system that supports the creation of a virtual community, through its 3D immersive interface. Although TAM has so far been utilised for online virtual environments like digital libraries and virtual workplace systems, it has not yet been used for a 3D VW within a formal higher education teaching program. Thus findings from this thesis can be interpreted for a

deeper understanding of how the medium can affect the users' attitudes and perceptions towards classroom learning technologies, using TAM to give a measure to the change in users' atttitudes before and after the application of the 3D learning modality.

3.2 Virtual Worlds: Alternative Media for a Virtual Learnscape

Back in 2007, VWs started to gather a lot of hype, especially in the area of economic enterprise. Castronova (2007) speaks in terms of an "exodus", whereby members of society are moving towards cyberspace, not just for entertainment but also for industry and commerce, as well as for education. A quote from his first book which was entitled, 'Synthetic Worlds: the business and culture of online games' says: "Clearly if social activity migrates to synthetic worlds, economic activity will go there as well" (Castronova, 2005, p. 255). This has been cited by a great many authors, including Jane McGonigal in her 'Reality is Broken', as an indicator of the importance which VWs hold over society and their potential impacts which go well beyond trivial leisure. Wasko et al. (2011) have looked at the reality of this statement and have highlighted results, published by KZero[2], and which have revealed figures escalating to 1.185 billion registered users in a number of VWs globally in the first quarter of 2011. The demographic map of the VW users shows that although a large percentage are past their teens, most pre-teenagers and adolescents seem to experience more the immersive environment through their avatar than possibly interacting (asynchronously) over a social network.

This holds a number of implications for the use and utilisation of VWs both in terms of economic activity as well as social activity. It would be wrong, as Castronova (2005) points out in his reflections, for higher education not to grasp this opportunity and harness the potential that these worlds are offering for an alternative way of doing education rather than the one which has been most often referred to as having reached a "status quo" (p. 252).

[2] KZero is a company which provides market analysis and trends in VWs and VW goods globally. Available Online: http://www.kzero.co.uk/ [Last Accessed: October 2011]

A recent article, featuring in a magazine reporting about enterprise in Virtual Worlds, revealed some amazing figures related to one in-world convention held for one of the most popular MMORPGs, World of Warcraft (WoW) (Korolov, 2011). According to the article, the convention was held inside a VW platform called Utherverse[3] during 2011. It had all the elements of a 'real world' convention with "trade-show, talks and seminars, guild parties and recruitment events, and tournaments" and attracted more than 3,200 visitors – the majority of which would be WoW players or fans. In all, more than $14,000 were spent over a span of two days. These figures are indicative that there is a movement under the surface of VWs and understanding it, to be able to harness and exploit it for the best possible use, is becoming imperative across all societal aspects and domains, more so in the education domain.

All the research currently underway, whilst directly or indirectly affected by the different technology platforms, suggests that there are important areas which still need to be investigated, such as the various interaction processes between VWs, avatars, content designed in VWs, as well as the behavioural processes involved in the interplay between real and virtual interactions. Recent studies seem to indicate a relationship between VWs and real life behaviour that may be linked to the way we assimilate knowledge from our surrounding environment, irrespective of whether that environment is 'real' or perceived (Thiruvengada et al., 2011). This is also in line with research and studies carried out in a number of areas related to cognition, user perceptions and the behaviour displayed as a result of virtual reality (VR) practices (Blascovich & Bailenson, 2011).

3.2.1 VW Features and Characteristics

Messinger et al. (2009) describe how VWs represent a breakthrough in one aspect of social computing, that impinges greatly on businesses and academia through the social ties that are established within the virtual environment. These ties are at the basis of a number of theories that focus on social learning. One specific concept that is ingrained in social learning theories is Communities of Practice (CoP) (Wenger, 1999). Outcomes from CoP build up on the collective intelligence through

[3] Utherverse is a VW platform, predominantly set up and targeted for a strictly adult audience, for social and entertainment purposes. Available Online: http://www.utherverse.com/ [Last Accessed: October 2011]

engagement in joint tasks that help community members share and exchange experience and expertise. This concept can be applied to VWs utilising their social traits. de Freitas's (2008b.) scoping research of the use of VWs in learning and training makes reference to a number of cases that discuss the integration of VWs in educational contexts, listing challenges and opportunities. Amongst these one can identify those related to the dynamics of social learning. In these contexts the VWs were used to create virtual communities based on open-ended exploratory and immersive 3D interfaces. Joint activities in these case studies make use of the 3D environment for users to create learning objects, which they exchange in the virtual marketplace or share information through virtual conferences and events placing experts as well as learners in the same space. The ambience and the 3D environment created also supports the possibility of serendipitous encounters that may lead to learning. Carey (2007) argues that immersive social experiences not only offer alternatives to face-to-face interactions, but can also provide new forms of human experiences, built upon a vast array of digital communication tools which can offer the same emotional satisfaction as that gathered from the social exchanges happening on the daily basis. This would imply that immersion is not just a hedonic diversion to the role users adopt, but it presents a degree of interactivity which allows users to flexibly construct their own space in the online environment. One view of VWs is that these were born out of a notion of creating virtual cultures (Stephenson, 2000). However, as Peachey et al. (2010) report, there is much more than meets the eye to VWs than being simply virtual social spaces.

de Freitas (2008b.), in her scoping study of VWs, makes a clear distinction between VWs used for leisure and those used for education and training. She describes the latter as *serious* VWs with a specific characteristic, which can be attributed to their immersive representational value and how this affects the individual's learning experiences. Carpenter (2009) describes the experiences in VWs as the connections which the users nurture as they interact with the 3D environment and with the other personalities inhabiting the world. This description fits with Carey's arguments that these 3D spaces may offer human experiences that would fulfil the emotional needs during human-human interactions. Thomas & Seely Brown (2009) argue that to achieve these levels of experiences, VWs have the ability to offer a space that can give rise to a sense of being and belonging, which the users create through

interactions with the 3D objects and with the other avatars. That sense of being inside a virtual space may lead the users towards the sensation of immersion, further aided by their virtual embodiment as avatars and their motion through space and time as they traverse the VW and connect to other avatars. Such connections may be supported and facilitated through communication over voice, gestures and text-based messaging. These modes of communication may be used to strengthen the social ties between VW participants through their interactions and user participation.

Carpenter (2009) discusses the characteristics that are associated to immersion and are most often attributed as being responsible for the success of VWs. These include the:

- immersive environment with a series of locations,
- avatar creation,
- interaction/communication with other players,
- interaction/communication with non-player characters (NPC) such as tables, chairs, screens and
- interaction with other world components such as the creation of 3D assets and world content.

Camilleri & Montebello (2008) have also explored the concept that VWs without a collective scope or domain remain void and fulfil nothing more than a static representation of content transmission. This is in agreement with the statement that the success of technology innovation is ingrained in human social practices and reflects the concept of communities of practice. In fact, according to Camilleri & Montebello (2008) the lack of presence in educational islands on one of the most popular VWs, Second Life[4], can be attributed to a lack of collective scope or motivation that would drive the users to return to that world without waiting for facilitator-led scheduled meetings. They also argue that a VW without avatar presence would limit the users' experience, thus reducing the possibility of in-world residents or other avatars to return to the world. A world with increased avatar presence, usually reports increased avatar interactivity. VW islands such as those which feature

[4] Second Life is a social virtual world created in 2003 by Linden Labs. Available Online: http://www.secondlife.com [Last Accessed: March 2012]

commercial dance and party activities, as opposed to educational activities, seem to naturally draw more avatar residents who are keen on sharing more than just static text, thus enhancing their overall individual in-world experience as they move towards a 'collective' involvement.

The concept of a "shared workspace" is also discussed in Messinger et al. (2009, p. 204) who describe the richness of the interactions in terms of the various possibilities and choices that can be experienced by the in-world inhabitants. The authors also describe the social interaction, which at the level of communication relies mostly on the co-creation of these interactions by the avatar residents themselves. VWs can also be described by their semiotic characteristics. Having a VW that offers a complex scenario can help learners construct meaning in the context of the learning setting. This semiotic feature is brought out more strongly through the use of multimodal sources, or as a result of a number of connections or networks in which the learner is involved throughout the virtual environment. This perspective ties in with the Connectivist theory of learning which foresees learning as a network phenomenon, aided by technology-based tools and applications and social connections (Siemens, 2004; Downes, 2008). Communication, through the use of media and language thus, according to Siemens, become outlets that help the externalisation of that which is considered as tacit knowledge. In the VW this can be manifested through the self-representation of the avatar. This self-representation also becomes an important part of not just what the in-world residents learn, but also how they learn. Minocha & Reeves (2010) refer to this phenomenon as a state of 'being there together', giving rise to immersion.

But self-representation is not just the only characteristic that makes VWs stand out from other Web 2.0 technologies that have been used for teaching and learning. Culture representation and formation and sense of presence are key factors that have been described as having influence on users' beliefs and their subsequent changes in behaviour.

3.2.2 VWs and their influence on User Behaviours

Black and Reich (2012) defend the view of culture as being seen as a "system of meaning that is shared by a social group" (Goncu & Katsarou in Black & Reich,

2012, p. 212). Black and Reich (2012) discuss the sociocultural theory in terms of learning in VWs. In their study, the children who are immersed in VWs bring with them prior experiences, social norms and modes of communication that are absorbed as part of the community culture. Boellstorff (2010) explores, through his anthropological studies conducted in SL, the establishment of communities through the organised events and the group formation that are characteristic of SL and observes how the individuals within the virtual group, use their personal experiences to contribute to the group's overall achievements. McGonigal (2011) also makes reference to the importance of culture in the community formation in game play and how this culture serves to give a new identity to the individual members of the game community. The group dynamics become such that in a VW, the group benefits from the individuals' experiences, and with the emergence of a modified group behaviour , each individual can in turn apply this new belief and subsequent behaviour to his/her real life settings.

This notion is not without its criticisms. Gauntlett (2011) defends the importance of becoming co-creators in the digital age, where creation and creativity are not understood in terms of the singularity of the final product, but as the process whereby something new can be done. According to Gauntlett, the gift of creativity does not lie in the talent of the individual to produce, but the sharing with the members of the community to help them transform into more learned individuals. Online, this community is considerably large. And the semiotics driving the dispersion of the newly created material is substantial.

Gauntlett argues that VWs like SL, can never equal or surpass the messiness of creation as manifested in the physical life. He argues that although Web 2.0 supports and facilitates the creation of content, most of this is provided in standardised formats with relative limitations in the experimentation of the creation process. This is also in agreement with Jaron Lanier's beliefs, in 'You are not a gadget' (2010). In this book, Lanier criticises the mass standardisation of digital practices and tools to accommodate for the masses or driven by the mass need. What Sir Tim Berners Lee (2009) had in mind when he first came up with the concept of the World Wide Web is the empowerment of the individual; a Gramscian way of dealing with hegemony in a society that was getting used to standardisation and status quo. However, Lanier

argues that the standard Web 2.0 tools are indeed limiting the experimentation by enforcing protocols. “The deepening of meaning”, says Lanier, “is the most intense potential kind of adventure available to us” (Lanier, 2010, p. 192)

However, VWs have an additional characteristic feature that distinguishes them from Web 2.0 static applications. Identity formation through the creation of avatars supports the acquisition of a visible presence – leading to the sense of being there – that supports the strengthening of the relationships that can be developed in the VW community (Annetta, 2010). This is something which users cannot achieve using any traditional LMS or Web 2.0 applications.

The sense of being there, impacts the act of doing which in turn affects the sense of presence. Jane McGonigal (2011) in her ‘Reality is Broken’ also discusses how the sense of presence displayed by certain attitudes during virtual and digital game-playing, is augmented when the community takes on a functional role, and the whole becomes larger than the self, thus contributing to building intrinsic motivation that leads to further engagement in the game itself. The users’ behaviour inside the virtual space is most often influenced by the needs of the virtual space that is designed and constructed but McGonigal argues that their behaviour outside that space can change as a result of their virtual experiences. This represents what is known as the collective intelligence. McGonigal’s social VW, *Evoke*, was designed as a collaborative virtual project, with the intent of helping users change their attitudes and behaviours towards some of the worlds’ social problems that deal with poverty, global warming, energy sustainability, empowerment for women. The setting it provided made it such that the players connected together and got involved in a social innovation project that extended beyond the Evoke VW. Although the project which ran in 2010 had some impact in relation to the projected targets, it still didn’t register the impact expected for the amount of money invested in the project. Possible trivialisation of societal issues through the game interface might have been a contributing factor to the lack of overall impact. The impact factor of this alternate reality game was measured in terms of the social innovation project the players would design, develop and manage in the real world. However changes in behaviour were not given a measure before and after the game, so the real impact of Evoke on user behaviour cannot be represented empirically.

However the elements of human-computer interaction (HCI) presented by Blascovich & Bailenson (2011) suggest that the human mind does not discern whether experiences that are immersive are virtual or real. For example, in the pit demo (p. 38) the participants involved in the experiment comment that when they are typically asked to don a headset and a virtual reality room is displayed in front of them, they are immersed in a way which also affects their physical actions. When inside the virtual room, a hollow deep pit opens up, and the participants are asked to walk across a virtual plank, placed strategically to enable crossing from one side to the other. The participants all typically report that they feel *fear,* externalised by physical characteristics such as sweaty palms, curled toes as they walk, etc. This indicates that virtual immersive spaces can lead to specific behavioural reactions in response to the way the brain construes perceptions from the information it gathers. This connection between the virtual space and reality has also been studied previously in an investigation by Meehan (2001) who gave a measure to the reliability, validity, and sensitivity of the physiological presence in a stress-inducing virtual environment. According to the author, the results show that users' behaviour changes as a result of the sense of presence following the virtual reality experience of walking across a virtual pit room.

Blascovich & Bailenson (2011) add another feature to the immersive virtual experience, including the "sensory information that makes people feel they are 'inside' the virtual world" (p. 2). The authors describe the different types of experiences tied to the brain processing functions as specific stimuli that trigger emotions, states of being and psychological traits. According to the authors, such stimuli do not necessarily need to be real as in representing the tangible world, but the same results, if not more, are achieved when the inputs are given from the virtual side of reality. The authors describe experiments whereby virtual elements impinge on and affect behavioural dimensions in the physical world. This vision opens a whole new perspective of existent research in the area of VWs, and rather than solely describing the level of immersion that one can achieve via the virtual worlds, one can research effectiveness as an outcome of behavioural changes induced via perceived information which is gathered from these 3D virtual experiences. This is also known as the placebo effect and has been investigated in areas dealing with pain management and control, (Hoffman, et al., 2001), anxiety related disorders (Ressler, et al., 2010),

and treatment of phantom limb pain using immersive VR (Murray, et al., 2010). In all of these experiments, VR has been shown to alter patients' real world behaviour through living through the various settings in an immersive environment. So far, there has been little evidence presented in the effects of VR and VWs on the users' change in behaviour in formal education settings. de Freitas & Maharg (2011) have presented some work about VWs and their use in education and learning. In their studies the authors, view learning as a product of change in users' behaviour. de Freitas &

Neumann (2009) had previously adopted an experiential model and applied it to the design of a 3D VW to illustrate the process of learning through exploration, reflection and experimentation. The authors propose ways of how changes in behaviour can emerge as a result of the users' traversal of the 3D spaces in a series of steps that move from the abstract, to the virtual and back to physical (lived) by going through exploration, reflection, formation of concepts, testing and finally constructing new experiences.

Figure 7 - The exploratory learning model (model adapted from (de Freitas & Neumann, 2009, p. 346)

Their model shown in Figure 7, uses an exploratory learning framework that merges Kolb's experiential learning concepts with Dewey's reflective paradigm in a cyclic representation, flowing from experience (thus relating to the learners' abstract, physical or even virtual associations), to exploration (where the learners have the possibility of roaming around the realms of their knowledge or abilities), to reflection (incorporating learning practices), moving then to the formation of abstract concepts and the reinforcement of ideas through testing. Although the model in Figure 7 does

not take into account the social theories of learning, there is the possibility of using it to build on the notions of communities of practice to feed in the knowledge possessed by each individual in the virtual community, contributing to the knowledge capacity of the group within that virtual environment. This can be done by framing the model in a social context, encouraging group exploration through collective task resolution and including the community in the reflective process.

The exploratory model is not a new concept as simulations are constantly being used in flight, health related training activities, such as operations, triage management and nursing. During these immersive experiences the users go through a series of experiences, where they are invited to explore, reflect, form abstract concepts and test out their newly found concepts, or acquired skills in a context which allows them to take decisions in a safe, risk-free environment.

The notion of experimenting in an environment which offers safety in the knowledge that the decisions taken are not going to have any impact on real life, may also be at the root of factors that may help users change their attitudes and behaviours in the physical world. Wang et al. (2009) discuss how the learners' attitudes towards their self and the others in a construed virtual community where it is safe to experiment, may help enhance learning arising from intrinsic motivation. The implications for learning and on the job training for professions or jobs traditionally thought of as having a large stress factor and risky, such as emergency first responders and air traffic controllers, are quite significant and needs to be explored further. On the other hand, teaching may also be viewed as having a large stress factor especially when dealing with difficult situations inside the classroom, where a large number of external factors come into play. As discussed previously another factor that seems to be increasingly affecting teachers' practices in the classroom, is the perceived imposition of technology tools for teaching and learning. Research from Chen (2010) shows that the improper use of technology practices could among other factors, give rise to resistance towards the use and adoption of learning technologies. Taking into account the above research in the area of VWs and VR for changes in user behaviour as well as previous research from de Freitas (2008) and de Freitas & Maharg (2011) it is understood that an immersive environment, such as a 3D VW can be exploited to

create the right setting which may be conducive to changes in teachers' behaviour towards the adoption of learning technologies.

3.2.3 Learning Activities in VWs: Modes and Modalities of Use

Kapp & O'Driscoll (2010) in their book 'Learning in 3D', discuss learning from the perspective of Web 2.0 as a new medium that makes use of collaborative and interactive activities supporting learning. Kapp & O'Driscoll (2010) discuss this modality for learning and posit that activities in the VW are the starting point for learning. Such activities include co-creation, role-playing as well as exploration of the 3D space. This tallies quite strongly with the exploratory framework model described in Figure 7 adopted by de Freitas & Neumann (2009). Through the social interactions and the virtual connections created, it is expected that learners reach higher competencies than knowledge transfer (Ibáñez, et al., 2010). If the immersive Internet is used in the classroom, applying technologies like VR and VWs for educational activities, and supporting online connections become important considerations.

VW exploration as an activity occurs as a result of an open-ended approach to learning (de Freitas, et al., 2010, p. 71). In the authors' later work, they focus on a positivist constructivist approach to pedagogy for the design of an exploratory experience in the immersive virtual space. The results from their studies indicate that one of the design characteristics of VWs for education includes structured in-world activities emphasising social interactions as part of the more holistic process of learning. Assessment of these structured activities, feedback and reactions to feedback, become an important part of the design of VIE. The multi-dimensional framework used for the study is coupled with an inductive research methodology in a bid to evaluate the participants' in-world learning experience. Although these preliminary studies have revealed challenges and strengths of the 3D learning experience, within the limitations set by the experiment, assessment of the learning experience in terms of the objectives proposed by the learning models has not been carried out yet and would have revelatory implications for trainers and educators.

Olasoji & Henderson-Begg (2011) argue that teaching strategies used for the real world classrooms would not be as effective if placed in the VW context. This is another debate which has sparked several discussions. Classrooms cannot be recreated

inside VWs. Olasoji & Henderson-Begg (2011) discuss a case study involving summative assessment processes for the teaching of the application of bioinformatics at a post-graduate level. Although the results promise some interesting preliminary findings on ways of using summative forms of assessment, the number of participants in the study is quite low, and empirical data for the participants' activity in SL is not presented. Such empirical data would give more detailed results which can be helpful in identifying student interaction processes contributing to identifying more detailed dynamics about in-world summative forms of assessment. Assessing students on their interaction processes in world might provide one possible way of assessment, rather than obtaining answers based on transferable knowledge processes.

3.3 Education in Virtual Worlds: Lessons Learned

A number of case studies examine the use of VWs in higher education. Dudeney & Ramsay investigate and discuss the four barriers to their effective use, namely "Institutional, Pedagogical, Technical and End-user barriers" (2009, p. 12). Many of these barriers relate to the difficulties in the uptake of the institutions to take up on these new and diverse technologies. Some of these difficulties also result from the technology itself that is as yet not mature enough for the adoption by users having limited expertise or no previous experience, as well as not adaptable to different devices and platforms. In fact many students, using standard netbooks or tablet devices may be pre-empted from logging into VWs because their machines do not support the 3D technology. In the search for VW platforms that could be used within the framework of PreVieW one needs to take into account these challenges and make provisions to try as much as possible limit such challenges.

On a different perspective, Broadribb et al. (2009) describe the approach which the Open University (OU) decided to adopt in view of VWs. OU had, in 2006, opted to choose Second Life (SL) as a VW platform due to a number of factors, including the wide popularity and accessibility it has acquired over the years, as its exponential growth in numbers of resident avatars gives an indication of the market receptivity towards these technologies and in particular this platform. OU also founded "OUtopia", an island officially opened in April 2009, and whose main scope was that of providing "virtual homes" or habitations which resident avatars can rent out and

use to "hangout" or chill out with avatar friends, or even for enjoying some moments of peace and reflection whilst being inside the VW. In fact, the report also highlights that "education is not just about classrooms or lecture halls. It's about establishing friendships and future professional networks, and those relationships flourish best in a social setting" (2009, pp. 3-4). Broadribb et al. (2009) report on more OU islands, used for both student, as well as staff development, with more emphasis and prominence given to in-world tutorial sessions and workshops. Outcomes projected from one such staff development workshop exercise conducted in-world, included the increase in confidence in handling situations requiring specific feedback, as well as the increase of the awareness of the different technologies which are in existence and evolving continuously (Broadribb, et al., 2009). The criticism of this approach is that without assessed targets that need to be achieved, student presence can be lacking. Factors contributing to this lack of presence can be the sense of triviality that is sometimes attached to hanging out in VWs. Camilleri & Montebello (2008) report on lack of presence in VWs that are designed primarily as educational hangouts.

In this case, it is planned that PreVieW should be designed to enhance serendipitous encounters between participants. These encounters can be supported through a series of virtual public events such as information seminars, where participants can get together, in small group communities to share experiences in their areas of expertise. However when such interaction processes are also part of students' assessed curricula, the likelihood of success increases.

Other case studies conducted in SL and which emphasise the social interaction processes established in the VW, have also been described in another Linden Labs report (2009). The New Media Consortium is a non-profit organisation with a vision of helping educators and higher education practitioners to interact and engage with emerging technologies. The island developed in SL serves as a focal point where researchers and educators can gather, discuss, experiment with, explore and participate in a number of live events. Various events have been organised to this intent over the years.

A number of conferences on VWs and the use of VWs in higher education and beyond, highlight several case-based scenarios taking into account the practical use and applicability of VWs. One such conference, AoIR Conference 9.0: Rethinking

Community, Rethinking Place, published one specific paper, which dealt with the description of a Danish SL project, "Library Hangouts", a project which places emphasis on user-driven objects in a virtual library. Thus, resident project participants, all librarians, co-created the design of the virtual library, in concordance with their group's needs. This element of co-creation is also discussed in terms of the technologies driving the physics engine in SL, and compares these with real world physics as objects are created (dos Santos, 2009). dos Santos argues that the hyper-reality sustained in SL may allow for experiences that are more experiential and creative in nature, in line with theories about game and play proposed by Papert (1998).

According to Jarmon et al. (2009), many educational practices continue to replicate the knowledge transmission model of learning and thus lack the opportunities for students to experiment with what they learn and with their creative ideas in real world and out-of-class contexts. There were a number of ways in which the students in Jarmon et al.'s experiment linked their learning inside SL to a real life context such as the connections between their learning and their academic discipline, or through continuous use further to the experiment, as well as the recordings of the perceived usefulness of the VW for more experiential forms of learning.

Burden, et al. (2008) describe an SL case study which aims to develop problem-based scenarios for healthcare students studying over distance. The project driving this case study includes the development of a virtual patient, the capability of simulating the various patient disorders which might be encountered and the ensuing response to the resident avatar's choice of preferred treatment. Moreover, at the backend a Web server carries the capability of storing the learners' (resident avatar) profiles and tracking their progress as they move along the pre-designed case study scenario. The backend interfaces the SL world through an MVP[5] controller (displayed over a Web page) providing patient data in an activity model driven by the integration of data availability models, encoding learner engagement models, and virtual patient data.

[5] MedBiquitous Virtual Patient (MVP) Working Group targets the development of standards and Web services, for the interoperability and integration of virtual patient learning content, developed for simulations and Web-based learning. The group provides standards and implementation toolkits for resultant activity models combining learner engagement encoding with data availability and virtual patient data, which describe the learner interaction processes as he/she goes through a patient simulation exercise. Available Online: http://www.medbiq.org/working_groups/virtual_patient/index.html [Last Accessed: October 2011]

The interesting aspect of this case study is in its design, as the VW platform is integrated with Web Services through the MVP controller. The case study involves paramedic training, and therefore requires problem-solving skills at a level which demands more flexibility in the choice of response on behalf of the trainees. The Web interface is rendered more dynamic and realistic through the use of the VW mechanisms where students not only visualise the scenes as the incidents unfold but they can also engage with the environment through their responses. The VW platform utilised is SL, as its design fluidity allows trainees to respond more openly to some of the scenarios illustrated. The success of this project is attributed also to the fact that the VW is associated directly to the paramedic training curriculum.

Camilleri & Montebello (2008) present a number of scenarios involving user creation in SL. Students following a course in artificial intelligence (AI) at the University of Malta were encouraged to learn through practice and therefore apply AI techniques to the creation of interactive objects and processes in SL. Amongst the "objects" or agents which the learners created, there was one which provided some entertainment for SL visitors on the island, through a game of draughts, that could be either played amongst avatars, as well as between an avatar and a computer-generated agent. Another project built on the same island included a "magic carpet", accompanying the avatar to specific locations without the need for teleporting[6], whilst another project automatically detected friends in SL and displayed their location. Avatars had the choice of wearing the friend finder if they wanted to be found on SL, and the friend finder would display a list of the avatars wearing the device and their subsequent location coordinates. All three projects target an enriched experience in SL, using communication as the main medium.

Although SL has been used as a virtual world platform in a variety of studies ranging from performance measurement in virtual theatre (Chafer & Childs, 2008), to teaching English as a second language (deJong Derrington & Homewood, 2008), and promoting community safety through crime prevention and awareness (Grove & Steventon, 2008), other VW platforms have also been used in various educational

[6] Teleporting is the ability of the avatars in-world to move between one island and another without either walking or flying, as is custom in a number of VWs, including SL.

contexts and training scenarios, especially those specifically concerning emergency training and first response, the military and healthcare (Minocha & Roberts, 2008).

VWs are also being experimented with in relation to scientific data visualisations. The Meta Institute for Computational Astrophysics, MICA, is a "professional scientific organisation based entirely in VWs" (Djorgovski, et al., 2009). Most of the activities held by MICA, relate to public outreach, education and dissemination. They hold talks, seminars and workshops in-world and they use SL as their VW platform although they have previously used Qwaq[7], and may use other VWs in the future as necessary. They have also broadened their scopes from collaboration to visualisation of numerical simulations in a goal to provide for a collaborative visualisation tool which users in VWs can make use of. Numbers and visualisations are also described in a paper by Sweeney (2008), relating to the teaching of Mathematics through the use of SL as a VW platform. Sweeney conducted an interesting experiment making use of eye tracking hardware to empirically determine the degree of immersion a participant feels, when he/she is inside the VW. Two VW platforms were taken into consideration during the experiment. SL was used as a platform to create a series of tutorial sessions, based on a number of concepts in Mathematics. The experimenter created different learning scenarios to accommodate the different learning needs and also to investigate whether differences in the virtual environment impinged on the degree of immersion experienced. Although the study group was fairly small and thus cannot be really representative of the larger population, the qualitative data collected indicated that general results in terms of attitudes towards the uptake of VWs, specifically SL, for tutorials were positive. The eye tracking hardware described in the experiment, did not give valid data and the analysis was carried out on a limited number of participants. However, the preliminary indications show that such measures might provide interesting results when comparing different scenarios, design considerations and different experiential activities.

The concept of scientific simulation in VWs is also discussed in Corbit et al. (2011). The authors take into consideration a project based in the Active Worlds[8] VW called

[7] Qwaq is a 3D collaborative environment providing a VW representation for group meetings. Available Online: http://www.teleplace.com/ [Last Accessed: October, 2011]

[8] Active Worlds is a 3D VW that offers a customisable environment in which to collaborate, play and create an immersive space. Active Worlds have an Educational Universe targeting specifically teachers and students and

SciFair. Although the project's concepts have roots in a real life Science Fair convention supported by the Cornell University, and originally intended as a public outreach, the VW project started targeting school communities through a project-based approach. The authors discuss how funding mechanisms were an important driver to shift attention from the evaluation of the project as a *fun* and *engaging* medium (albeit trivial) to a process that assesses the effectiveness of learning taking place inside the VW. The methods which the researchers adopt to give a measure of the effectiveness of this medium, include standard pre- and post- test surveys, standardised project assessment by teachers[9], analysis of student projects, and data mining techniques retrieving information based on student chat logs, as well as object data logs (Corbit et al., 2011, p. 163). The latter uses semantic and social network analysis technologies which, according to the authors, are imperative in tracking student progress in project-based learning inside VWs. The application of semantic technologies for assessment in education, and more specifically inside VWs, is an area of research still in its infancy, and combines technical expertise with pedagogic foundations supporting 21st century learning skills.

Burton, Martin & Robins (2013), describe another study using the 3D VW modality from a student engagement perspective. In their experiment, the authors use three theoretical underpinnings; student engagement, knowledge creation and the expansive learning theory in the creation of a VW for undergraduate students learning about game design. In their study, the researchers recruited a number of students from two different universities, to participate in a 3D VW whereby through solving quests and missions, their programming skills would be enhanced and enriched. Thus the learning activities were designed around a dialectic constructivist modality where the participants were expected to interact with both the VW generated content and missions as well as the other avatars present. The authors gained a number of insights from the findings. The two main discussion points that warrant further discussion

include a number of projects, such as the popular RiverCity. Available Online: http://rivercity.activeworlds.com/ [Last Accessed: November 2011] use Active Worlds as their 3D Platform. Available Online: http://www.activeworlds.com/ [Last Accessed: November 2011]

[9] This includes a detailed rubric integrating aspects of knowledge, skills and competence related to the VW medium as well as skills attributed to the 21st century learner in society, characterised by life skills, learning and innovation, as well as media and technology skills. It also integrates the National Educational Technology Standards proposed by ISTE (International Society for Technology in Education) also known as ISTE-NETS and widely adopted in the US and worldwide. Available Online: http://www.iste.org/standards/nets-for-teachers.aspx [Last Accessed: November 2011].

include the different roles which the participants undertook throughout the VW experience to help them solve problems, and the importance of knowledge creation focus in the design of the VW learning activities. In the first instance, the different roles which the participants took helped them enrich the level of engagement with the content of the VW in a way that they took their conversations from the virtual to the real world to be able to solve the challenges given. These roles, which were also facilitated and supported by the instructor, helped them work collaboratively on a task, and construct meaning from the context in which the knowledge was encapsulated. In the second instance, the authors discuss how the content creation can contribute to a more meaningful learning experience in a VW whilst allowing time for reflection on the creation of their artefacts would create a knowledge spiral amongst the participating learning communities.

This study uses a theoretical framework which is built around 3 concepts, namely strategies enhancing student engagement, tacit and explicit knowledge creation, and the expansive learning theory, proposed by Engeström (as cited in Burton et al. 2013, pg. 69). It is the combination of these theoretical facets that helps the authors propose a design for a VW that goes beyond the aesthetics of the 3D environment and places the focus on its application for learning.

The concept of learning communities in VWs is the focus of another study, by Ferguson et al. (2013). In their investigation the authors view learning as a social process occurring in the various conversations held inside the VW amongst two different and defined learning communities. Like Hossain & de Silva (2009), Ferguson et al. (2013) attempt to understand how the social ties help learners create meaning even though they may hail from different social contexts and cultures. In their studies the authors differentiate between the discourses held in a formal and non-formal learning environment. They posit that in the more formal virtual environment the learners' discourse is situated in the teacher context, and has very clear boundaries set by the learning parameters, whereas for the learners situated in a non-formal learning context the discourse is more varied and thus the linguistic ties, may not support the networked learning communities. In their research they analyse VW community characteristics in terms of 4 key elements: spirit, trust, trade and art that emerged from a number of forum threads between two communities situated in the

Schome VW Park Project[10]. The findings from the study give indications to practitioners and teachers using the VW for learning that the elements of discourse might provide to be important components. This also gives an indication that studies of the discourse that goes on in VW communities can give valuable insights into the more tacit forms of knowledge that might reside in the formally and informally constructed conversations.

In all of these case studies, certain elements of best practice emerge. These include:

- Using technologies that are accessible (supported through the users' devices, operating systems and available bandwidth)
- Fostering serendipitous encounters through virtual get together meetings
- Setting up communities of practice (targeting specific goals which learners need to achieve)
- Encouraging exploratory environments (through an interactive 3D environment that changes over time, and which offers enough space the users can navigate through)
- Fostering co-creation and collaboration (through the assignation of specific tasks)

PreVieW needs to make use of these lessons learned from case studies based in literature, to support an environment that is conducive to learning as that characteristic of the digital era.

3.3.1 VWS IN PRE-SERVICE TEACHER EDUCATION

Recent studies show that VWs are also being explored for pre-service teacher education. Although there aren't many studies that use VWs in a formal teacher education curriculum, many of these studies show the different ways in which this 3D modality can show different ways in which VWs are being exploited for an in teacher education. In one study, Campbell (2009) developed a pilot in which pre-service

[10] The Schome Park Project was part of an initiative set up to determine the strengths, and challenges that characterized Teen Second Life (a secure VW for teenagers). More information about the pilot project which ran from 2007-2008 can be found online from: http://kn.open.ac.uk/public/getfile.cfm?documentfileid=11344 Last Accessed: April 2015

students were enrolled in SL to be able to produce a teaching resource, which they could then use during their classroom teaching. In this instance, Campbell made use of a problem-based approach using a constructivist theoretical framework.

Gregory et al. (2011) used SL's role-playing affordance to aid pre-service teachers' level of confidence in their professional skills and abilities to handle a class. In their experiments, the authors recreated a virtual classroom in SL including indoor and outdoor settings. The project, VirtualPrex[11], was introduced to help teachers gain more confidence in their classroom management skills through the use of a 3D VW. Virtual agents were included as young students whilst pre-service teachers were asked to teach them a specific school subject. At the same time, collaborative learning was also introduced in the project, as small clusters of pre-service teachers, would have different roles, both as young learners as well as teachers in the virtual classroom during the teaching activity. In their studies, the authors created a number of resources as well as machinimia which the pre-service teachers would then be able to review, and reflect upon. This project's success depended on the realistic behaviour of the virtual agents and the pre-service teachers' skills at role-playing, whilst practicing their teaching and classroom management competences. Although the project has produced the target outcomes, further studies are needed to determine the effectiveness of this modality on the teachers' classroom management skills over a period of time and how this affects their teaching in the long term. Muir et al. (2013) also focus on classroom practice when SL as a VW in a teacher education program. They use role-play to help pre-service teachers act out different student behaviours that they might face in the classroom. The authors use reflection to help pre-service teachers through their learning process and trajectory within VWs.

Inman & Wright (2011) were amongst the few researchers in VWs who exploited SL during a formal teacher education program to foster in pre-service teachers the 21st century skills needed for teaching practice in the classroom. The results from this study show that VWs have an impact on the pre-service teachers' acquired 21st century skill set that include creativity and innovation, critical thinking and problem solving, and communication and collaboration. This was done by exploiting creation

[11] VirtualPrex is a project designed as a 3D virtual world for pre-service teachers to practise professional experience. Online: http://www.virtualprex.com [Last Accessed 2014]

in SL as the pre-service teachers created, designed and built a number of objects and artefacts in the VW. User-generated object creation in VWs was also used by Jacka & Booth (2012) as part of their studies with pre-service teachers and the teacher education program. In their study, the authors describe the reflections from one pre-service teacher who generated a VW experience for young children as part of her classroom teaching practice. Although the reflections indicate a positive attitude toward the use of the VW, since this study has been done with 1 participant it cannot be generalised for a greater audience.

Selvester (2012) used SL to help pre-service teachers come to an understanding about their beliefs in relation to gender and social roles; a field that is attributed a considerable degree of importance in the pre-service teacher education curriculum. In SL, the pre-service teachers use their avatar's opposite gender identity to understand how they themselves perceive gender roles. In this study, Selvester has made use of an experiential theoretical framework applied to VWs to shape pre-service teachers' attitudes about the role of gender. Although the pre-service teachers' response in this investigation tallies with Blascovich & Bailenson's studies (2011) that users may change their behaviour through role reversal and virtual embodiment, more studies need to be carried out to determine to what extent would the identities established in VWs can affect the teachers' daily practice in the classroom. The case studies outlined in this section show that VWs can be utilised for teacher education in various ways. These include but are not limited to:

- Role-playing
- User-generated 3D objects as resources;
- User-generated VW experiences for learning;
- Identity manifestation.

Existing gaps in research indicate a need to understand how social learning theories can be applied to the design of VWs to help shape attitudes and behaviours for pre-service teachers.

3.4 CHAPTER SUMMARY

The research questions focus on identifying how the 3D VW medium influences teachers' perceptions about classroom technologies. This review has described a number of barriers associated to the adoption of technology practices in the classroom. Research indicates that teachers' attitudes and perceptions are important factors limiting learning technologies adoption in the classroom. For this reason this review has illustrated the two main technology models that have emerged as a result of investigating teachers' attitudes towards technologies, and how technology training can be integrated in teacher education courses and practices. In the context of this thesis, the model that has been chosen to provide an answer to the research question is an adaptation of the TAM, by giving a measure of the changes in perception after the PreVieW experience. Moreover the research questions seek to understand if the VW, as a medium, influences users' attitudes and perceptions to technology, what factors would be responsible for this influence, and whether the social connections formed in the VW would affect any changes in users' perceptions. This review has described parallel studies that have identified VWs as media with potential to impinge on user perceptions and attitudes through immersion. Case studies indicate that when social interactions, opportunities for reflection and an authentic learning setting are integrated in the virtual experience design, the likelihood of changes in behaviour increases. The case studies about the application of VWs in Education, and more specifically teacher education, have provided best practices informing the design of PreVieW and its related activities. Chapter 4 will provide a more detailed overview of the research methodology and PreVieW design.

CHAPTER 4

METHODOLOGY & DESIGN

4.0 INTRODUCTION

Driven by a post-positivistic philosophy, this chapter describes the conceptual underpinnings that shape the design of the investigation methodology and of the PreVieW experience. The design needs to bring together the theory to the practice of integrating learning technologies in the classroom. The methodology proposed follows a deductive approach, where the formulation of the hypothesis that the use of the 3D VW would have a positive influence on the pre-service teachers' attitudes towards classroom technologies, is tested during a 13-week experience. Data is collected through a pre- post- experience survey using an instrument derived from TAM, data logs from the users' VW text-based interactions, and focus group interviews. The section that follows discusses the theoretical concepts grounding the design of the VW illustrating how these concepts have been integrated in PreVieW.

4.1 CONCEPTUAL UNDERPINNINGS

The pedagogic design in PreVieW is informed by 2 conceptual underpinnings grounded in social learning theories.

Connectivism, as a theory proposed by Siemens (2004) and Downes (2008), guides the researcher's epistemological stance on learning in the digital age. The understanding of the term classroom learning technologies is also viewed from this theoretical lens. The exploratory learning model proposed by de Freitas & Neumann (2009) informs the design of the 3D space to offer to the participants an environment that is authentic and suited to their needs.

In this thesis, Connectivism is used to inform the design of the learning content and the activities held in the VW vis-à-vis the framing of classroom learning technologies. The notions of this theory, which are of particular interest to this thesis are how learning happens in various ways (including email, communities (online and offline), web searches, conversations, courses, etc.), and that knowing where to find reliable,

valid and meaningful information in its context, is ultimately a more important factor in today's learning than knowing how to operate a tool or use an application. In the classroom context, this is translated to the ability of a teacher to respond to the students' needs and learning requirements on the fly, using learning technologies to engage students with the topic or current content and bridging the gap between the content and the students' online experiences outside the classroom. In PreVieW, this theory will be integrated by providing the virtual space, the interactive 3D objects and tasks that would help them connect to the 3D VW, to each other, and to other external sources. PreVieW will provide the pre-service teachers with the opportunity to practice, experience, experiment with and reflect on learning technologies in a relatively risk-free environment using the exploratory learning model (ELM). This model adopted by de Freitas & Neumann (2009) [Figure 7] proposes a design for the VW hinging on a learner pedagogy that is driven by experience and exploration. Using this model for the design of PreVieW would offer the learners the opportunity to share their experience of the real world with the other VW participants, whilst at the same time, reflecting upon the experience and creating meaningful experiences for their teaching.

The representation through the avatars and fidelity to real world structures is present in the meta-reflection phase, as the participants have the possibility of using their avatars to reflect on the content and structures held inside the VW. The context helps the participants in the formation of new concepts, and to test them in the different situations. In PreVieW this model representation is integrated in the user interface, as the 3D environment offers a space where the avatar participants can work together (collaborative features), share their experiences (features and settings supporting and facilitating communication), and be able to test their ideas out in different situations and environments (presented during group information seminars). The sections and sub-sections that follow will discuss the design of the investigation in more detail.

4.2 RESEARCH DESIGN

The sub-section below describes in more detail the purpose of a multi-strategy design as the approach chosen for the investigation on PreVieW.

4.2.1 MULTI-STRATEGY DESIGNS

The complexity of the research indicated in this investigation lies in the attempt to bring together educational research and practice, and the design for virtual human-to-human interactions. Robson (2011) describes the combination of strategies for use in this type of complex research as a multi-strategy approach. Both Robson (2011) and Bryman (2012) argue that although there are differences in the design, approach and analysis of quantitative and qualitative data, the use of a mixed strategy in no way compromises the validity or the reliability of research unnecessarily. They also argue that in fact, both quantitative and qualitative methods rely on grounding from the analysis and interpretation.

Robson (2011) describes six main types of multi-strategy research designs. The first three are sequential in nature, meaning that one method is given precedence over the other. These include the sequential explanatory design (where quantitative data collection and analysis precedes the qualitative one), the sequential exploratory design (where the qualitative data collection and analysis precedes the quantitative one), and the sequential transformative design (where either one or the other method is given precedence and results are brought together during the interpretation). The other three remaining designs offer concurrency in methods. These include the concurrent triangulation design (where both quantitative and qualitative methods are used at the same time, yet independently from each other), the concurrent nested design (where a secondary method is embedded within the research investigation), and the concurrent transformative design (which is guided by the researcher's use of a specific theoretical set or framework).

For the purpose of this thesis, and to be able to answer proposed research questions and hypotheses, the concurrent triangulation design is chosen, where both quantitative and qualitative methods of data collection and analysis are used concurrently, yet independently from each other. The benefits of the use of a multi-strategy design lies in the ability of triangulation of data to increase the validity of the research itself. It

also finds its use in giving a sense of completeness to the research presented. Each approach that has been used in the research has its own weaknesses and can give rise to multiple errors. By combining methods, this research attempts to minimise the weaknesses, reduce the errors and give a more objective perspective to the results presented. By using qualitative data to illustrate the quantitative aspect of the data, this thesis attempts to help describe the phenomenon of social collaboration occurring inside VWs. Cohen et al (2007) identify a number of threats associated to the validity of mixed methods research. The table below addresses some of the possible solutions

Table 1 - Threats to multi-strategy research process

Threat	Description	Solution
Timescale	This refers to the period during which the investigation is held.	Since this VW experience is done as part of the teacher education curriculum it has been assigned a timescale of 1 semester out of the 3 that make up an academic year for a PGCE program of studies. This is considered as an ideal timescale for the experience as it is neither too brief nor too long, thus limiting the threats to the validity of the research.
Adequate resources	This would ensure that at the beginning of the investigation, provisions are made so that there are adequate resources sustained throughout the investigation.	Provisions have been made with AvayaLive Engage technical support team to be provided with adequate technical assistance during the period of VW design and data collection.
Methodology Selection	This refers to the selection of the methodology to answer the research	The mixed methods approach has been chosen on the basis of the complexity of the

	question.	research question. It is understood that the use of one method and approach will limit the validity of the research.
Instrumentation selection	This refers to the way the instrument for data collection is chosen.	Following the literature review in Chapter 3 it was concluded that an adaptation of the TAM model would be better suited to answer the research questions in this investigation.
Sample	Using an appropriate representative sample decreases the threats to the validity of the research.	In this investigation an entire cohort of PGCE students is chosen as a sample.
Demonstrating validity of different approaches	This includes conclusion, internal, constructs and external validity for both quantitative and qualitative approaches.	Tables have been drawn up in sections 4.3.1.1 and 4.3.1.2 with more details about the provisions taken to limit threats and address solutions for increased validity in the research approach.
Using appropriate instruments	This refers to the readability and comprehensiveness of the instructions given for the data collection.	To limit this threat, a pilot study is carried out with a target audience, to identify possible ambiguity in the questions.
Experimenter effects	This refers to the deliberate and unintentional influences which the researcher would have on the participants.	Since during the course of this investigation the researcher accompanies the participants in the VW experience, this can be a major influence in

		the way the participants perceive technologies. The researcher has the dual role of the tutor who guides the participants in their exploration of the VW and its contents. This is the reason why the reflections from both the participants, as well as the researcher, are collected separately, coded and then analysed for common themes.

In this thesis the VW experience extends to the period during which the participants participate in the research and may be referred to as the period of experimentation.

A true experimental design, which is held under controlled environmental conditions and with randomised sampling of participants, carries enough ethical and logistical implications to discourage the use of such a methodology in educational research. On the other hand, quasi-experimental designs for the evaluation of a program of studies would sample a group using either a selection dependent on specific characteristics or sampling by convenience. A quasi-experimental approach is used to recruit and sample the participants for the VW experience (all participants are enrolled in a PGCE program of studies), and the pre- post-experience survey is used to measure the change in attitudes of the participants prior to and after the completion of the 3D experience. The views and the perspectives collected as qualitative data are used to illustrate the pre- and post- experience quantitative data that give a measure of the self-reported change in attitudes of the participants before and after their experience.

This combination of methods is also complemented by additional data collected from the participants to trace their learning experience inside the VW. A SNA is used to show participant presence and the frequency of their interactions throughout a 13-week immersive experience.

In this dual quantitative-qualitative approach, the initial theories or ideas lead towards the conceptualisation of a theoretical pattern. At the same time, the observations arising from the experimentation period are translated into data, from which observational patterns are extracted. Data collected through this process are categorised using coding. Pattern matching is carried out to identify common traits in both the theoretical and observational patterns.

4.2.1.1 QUANTITATIVE METHODS

This quantitative approach is used to determine the relationship, if any, that exists between the VW experience and the participants' perceptions and resulting behaviour towards learning technologies. Although the quantitative measures on their own are not comprehensive enough to provide empirical evidence as to whether the VW experience itself has effects that can be translated to a change in real world behaviour, the statistical results can give an indication that there are grounds for digging deeper into the phenomenon.

DATA

The one group pre- and post-experience research makes use of an online survey tool given to the participants at the start of the VW experience and at the end of the same experience[12] [Appendix 11]. This survey is based on a number of indicators emerging from the original TAM (Davis, 1993). The TAM instrument uses multiple item scales for a) perceived usefulness b) perceived ease of use and c) behavioural intentions. The TAM instrument has been widely validated as shown by Venkatesh & Davis (1996). However, as discussed in Chapter 3 of this thesis, subsequent models include attitude, perceived complexity and voluntariness as fundamental items that provide a more accurate measure of the technology acceptance and adoption by teachers (Teo, 2009). The complete set of technology acceptance dimensions thus include 6 items: perceived usefulness, perceived ease of use, behavioural intention, attitude, perceived complexity and voluntariness to use learning technologies.

[12] Data obtained from the survey was deleted immediately upon download to protect the privacy of the individuals who submitted the information.

TAM can be adopted and applied as an instrument in a wide array of technological contexts in such a way that any item can be revised by substituting a term with any technology-specific terminology that is at the focus of the study.

For the purpose of this thesis this was replaced by the term Internet applications. This is in light of the culture of discourse practiced by the participants following the pilot study. In their discourse, the participants interpret the various technology-based practices of the 21st century as mostly dependent on Internet connectivity and applications.

In this context, a relatively heterogenous cohort of 111 pre-service teachers following a one-year PGCE course are enrolled in a semester long study-unit, held inside a virtual world. Out of the 111 participants who started and completed their PGCE program, 74 submitted their information for both the pre- and post-experience survey. Out of the 74 participants, 18 were male and 56 were female. A demographic analysis of the 74 participants who submitted their data shows that 52 were between the ages of 21-25, 14 were between 26-35 and eight were between 36-55. These clusters of age groups were chosen on the basis of the number of participants in each cluster. Since the majority of the participants fell between the 21-25 age group, it was decided to split the other age groups according to the number of participants. Three clusters were chosen to get more in-depth information for the analysis and which can be used during the inferences section. Pre-service teachers enrolled in the teacher education program at the Faculty of Education, can opt to follow different fields of study which then lead to a specialisation in the teaching area. These fields of study have been categorised into three distinct clusters according to the subjects on offer in the program. These clusters are humanities, sciences and languages. One-way Anova tests are run to analyse the correlations of the three factors of gender, age and field of studies against their self-reported attitudes in the post-experience survey.

APPROACH

The approach adopted for this data collection is a quasi-experimental approach, with a non-randomised one group pre- and post-experience survey. An observation (O1) is carried out using a survey method. The survey is given out to all the participants prior to the start of the course. The course study-unit is delivered using a 3D immersive technology platform in an attempt to understand what type of learning can occur,

whether the medium can contribute to change attitudes and perceptions vis-à-vis technology acceptance and whether, if at all present, those changes last over a period of time. Observation [an outcome assessment] (O2) is carried out after the study-unit delivery, using the post-experience survey tool given to all the participants. Further to that, a selected group of participants is chosen to participate in a focus group session with the aim of trying to gain some understanding into the learning mechanisms triggered by the immersive experience.

In this pre-test post-test research method, the quasi-controls are determined by the population characteristics, which will be used to predict specific between-group differences. The population taken from a group of pre-service teachers following a PGCE program of studies will be characterised according to their subject/s of specialisation. The outcomes will be measured in terms of the test scores.

METHODS

The methods for the quasi-experimental approach include:

O_1 *– Pre-test using a survey tool for data collection*;

The survey tool (Appendix 11) is adopted and adapted from the validated TAM instrument to measure the perceptions about learning technologies and the consequential acceptance and adoption of technology in the classroom.

The pre-experience tool that is used during the study contains 17 multiple scale items categorised under the 6 TAM headings: perceived usefulness, perceived ease of use, behavioural intention, attitude, perceived complexity and voluntariness to use learning technologies.

O_2 *– Post-test using a survey tool for data collection;*

The survey will use an extended version of the pre-test survey with 28 multiple scale items using the same 6 item categories as in the pre- experience tool (Appendix 11). Its aim is to give a measure of the difference in perceptions following PreVieW.

The aim of this pre- and post-test approach is to determine the inferences arising as a result of the VW experience. The interpretation of the results needs to be backed and

validated by additional data, since the interpretation of the causality of the experience can be subject to other variables affecting the research.

Since the pre- and post-test results are used to give a measure of changes in attitudes and perceptions, the participants' responses cannot be kept anonymous. All ethical procedures are followed to protect personal data at all times.

Parametric tests are used as methods of analysis for the data collected. In these tests it is assumed that the population chosen is reflecting a normal distribution of the overall population with the variances known. The tests performed include the paired-sample t-test and one-way Anova to provide the correlations amongst gender, age, as well as study background, in relation to technology acceptance. One-way ANOVA is a parametric test used to compare the means of two or more independent groups making inferences on the population means. The paired-sample t-test is a test statistic used to test the null hypothesis which states that there is no difference between the pre- post-experience means value.

$$t=d/s_d$$

where

$d= 1/n \sum_{i=1} (x_{1i}-x_{2i})$; the mean of the signed differences of the paired data and

$s_d = s/\sqrt{n}$; the standard error of the mean where s is the sample standard deviation.

One-way ANOVA is used to compare the mean scores, between several independent groups in the pre- post-experience: age, gender, field of study.

The correlation between the complete set of variables is also interpreted in terms of data reduction using factor analysis. Using this method the correlation between the larger set of variables is extracted from a smaller number of latent variables. One popular method for carrying out factor analysis is the principal component analysis which is used to determine which of the variables listed as dimensions are responsible for the skewness of the data. The principal component analysis looks for a few linear combinations of the observable variables which can be used to summarise the data, losing as little information as possible in the process. This type of analysis seeks those linear combinations of the observed variables which account for the greatest amount of the variation among a set of variables. Whilst the first principal component

accounts for the largest amount of variation, the second principal component is linearly uncorrelated to the first component and accounts for the next largest amount of the variation, and so on. The complete set of principal components accounts for all the variability in the data.

VALIDITY

Validity in this thesis, is considered from the following four perspectives:

A. Conclusion Validity
B. Internal Validity
C. Construct Validity
D. External Validity

Each of these validity processes is described in more detail below.

Conclusion Validity

This type of validity is defined as the degree to which the conclusions reached in a specific research are reasonable. Since this thesis asks if the VW experience, PreVieW is able to model participant behaviour in terms of their classroom technology practices, it is important to ascertain that the conclusions reached are from this investigation are believable. The table below indicates the measures used in this investigation to increase the reliability of the findings, and strengthen the conclusions reached.

Table 2 - Design elements for conclusion validity adopted from (McMillan & Schumacher, 2010)

Design Element	Description	PreVieW
Use of a standard protocol	A standardised investigation would ensure that the same conditions exist each time interventions and measures are administered.	The VW research makes use of the TAM to develop the instruments for the pre- and post- tests. Should the intervention be repeated, the actual world experience might be likely to change, due to the different participants' reactions. However, the

		instruments and the nature of the investigation would not change.
Use of instruments that provide reliable scores	Measurement is more consistent by using reliable scores to reduce random error.	Scores are based on a 5-point Likert scale. The mean of all the scores under group headings was taken to compare the pre- and post-experience surveys. This was done to minimise the errors that may result from each individual item.
Use of homogenous groups of participants	Participants in each group have same age, gender or ability. This helps reduce masking the effect of an intervention.	In the VW research a single group was used. This renders this element null.
Use of accurate data coding and entry	Accurate data coding reduces errors.	Data entry was carried out using an online survey tool, whilst coding of the data was carried out using SPSS.
Increase of intervention effects	The greater the difference in the intervention between the control group and other groups, the more significant the differences would be.	No control group was used. The intervention was completely different from any other modality for learning to which the participants have ever been or are currently exposed to.
Use of large samples	Random error may be reduced when larger sample groups are used.	In this VW research, the whole group population of PGCE enrolled students was chosen.

Internal Validity

Internal validity is understood as the degree of accuracy with which the modelled behaviour can be viewed as a direct outcome of the PreVieW experience. In this case the threats to the internal validity that have been identified include:

Table 3 - Threats to internal validity

Threat	**Solution proposed in PreVieW**
History	In this thesis, the participants are all taking the PGCE program of studies. Although there are other parallel subjects being taught concurrently, thus increasing the threat of having external effects that might impinge on the participants' behaviour, this threat is minimised as the other study-units do not involve the application of learning technologies to classroom teaching.
Maturation	It is expected that the participants change throughout the experience as a result of different encounters in their program of studies. However to minimise this threat, provisions are made to encourage the participants to log in to the VW frequently and activities are designed so that they can explore, and experiment with different learning technologies using the VW as a medium.
Statistical regression	This type of threat occurs mostly due to the unreliability of the instrumentation measures and as a result of the participants' regression in scoring. To minimise this threat a validated instrument is used (TAM) for the pre-post-testing.
Testing	The sensitisation of the participants to the nature of the research is threat that can arise from the pre-test and thus affect the results in the post-test. In this thesis, the validated TAM instrument, is used to minimise this threat.
Instrumentation	To avoid unreliable testing, the validated TAM instrument is adapted and adopted. This is done to reduce the threat to the internal validity of the research.
Selection	In this thesis selection bias was limited, as the entire PGCE

	cohort for 2012/2013 was recruited.
Experimental mortality	Dropouts are limited as this investigation was held as part of a formal teacher education curriculum. This threat is also minimised as this experience ran for 1 semester in a 3-semester program of studies.
Type I & Type II errors	These errors are addressed by keeping the level of significance in statistical analysis at $p<0.05$, thus balancing Type I & II errors.

Construct Validity

According to Cohen et al. (2007) the construct validity concerns the extent to which a particular instrument for data collection, in this case TAM conforms to the theoretical context in which it is placed.

. Three threats, identified by McMillan & Schumacher (2010), include:

- The lack of adequate definitions and explanations of the constructs prior to the data collection. The TAM, in this case is an instrument that has been previously validated, to predict the degree of behavioural intention to accept and adopt technologies in context.
- The mono-operation bias includes the fact that this experience has run only once. For this reason, the results can be said to reflect this particular instance of PreVieW held with pre-service teachers during the year 2012/2013.
- The mono-method bias refers to the limitations to using one way to collect measurements. This is the reason why a multi-strategy approach has been chosen for this investigation.

External Validity

The external validity of this investigation can be described in terms of two ways in which the results can be generalised;

- Population External Validity
  The target group in this investigation is following a teacher education program at higher education. Pre-service teachers belong to the work force dealing with

vocational professions. The nature of the participants is driven by their profession, which will have them in turn affect other human beings during the course of their lives. Any profession with an interest in propagating learning can be equated to the population chosen for this research.

- Ecological External Validity

  The VW experience and the design of socio-collaborative activities can be replicated. However, owing to the fact that the researcher in this case is also the guide and the content designer, there is a limit to how much this same intervention can be extrapolated to other groups of pre-service teachers if the researcher is not present throughout.

4.2.1.2 QUALITATIVE METHODS

Although qualitative research can be quite fluid, the nine key characteristics described by McMillan & Schumacher (2010) define the nature of the research and the interpretation of the data in context. The characteristics, according to the authors, may vary to some degree in the different studies.

Table 3 (shown below) outlines the key characteristics of this qualitative research, whilst giving a brief description of each characteristic and how this is reflected in the VW investigation.

Table 4 - Qualitative methods adapted from (McMillan & Schumacher, 2010)

Key Characteristic	Description	PreVieW
Natural Setting	Research takes place in the participants' environment such as the classroom for practicing teachers.	The research takes place in a completely different setting to what the participants are normally used to. Whereas the participants are used to walled classrooms in a campus environment, this research moves away from the traditional method, to offer learning in a VW setting where the participants have full control

		over their avatars and the learning which occurs. This is done to create an experience that occurs outside of the participants' expectations but within the remits of their experience. It would also encourage more exploration of an environment that is different from that which they have become used to.
Context Sensitivity	Human behaviour, complex as it may be, is strongly influenced by the context in which the human finds himself/herself. A teacher may behave differently in different situations depending on the surrounding environment.	In this experiment, the learning environment will change from the traditional class-based one and therefore, the only expectation for this qualitative data collection is related to the participants' behaviour inside the VW.
Direct Observation	Most often the researcher spends time with the participants observing them. The collected data are usually obtained directly from the primary source.	In the context of the research, it is being proposed that the researcher spends some time observing participants during their VW experience.
Rich Narrative Descriptions	The qualitative data contributes to understanding the participants' perceptions.	The data from the researcher will be presented as weekly reflective entries. Data are also collected from the group interviews and transcribed into textual form.
Process Orientation	The process leading to the resultant change in behaviour is as important as	The direct observations and group reflections are expected to provide some insights into the "how"

	the outcomes. The question of "how" is as important as to the actual results emerging from the specific variables affecting the behaviour.	process that can lead to a change in behaviour.
Inductive Data Analysis	This is an important aspect of qualitative data research as data are collected from the bottom up, that is the data are collected first and then generalisations are made to reveal the *big picture* such findings would indicate.	Data are collected during and after the VW experience. Analysis and interpretations follow after.
Participant Perspectives	During observation, the participants' point of view is very important as the environment surrounding them is interpreted in terms of the participants' perceptions.	During this experience the participants are invited to give their feedback and views about the VW. They are also invited to attend a reflective group session in the VW to discuss their experiences and thoughts about it.
Emergent Design	The emergent design is built from the characteristics mentioned above, as the bottom up approach and the participants' perspectives all point towards a type of design which does not make any assumptions or build up on any preconceptions.	Although the participants go through a VW experience, there is no structure which the participants are asked to follow. There is no predetermined sequence of events that will be measured.
Complex Understanding	Any human behaviour is associated with complex	The investigation will take into consideration the different

and Explanation	systems, and studying such behaviour cannot be simplified by quantifying values using one perspective. Thus, complexity warrants for multiple perspectives and qualitative research has to reflect the different perspectives.	complexity factors coming into play within VWs and whether these affect their resultant behaviour towards the integration of technology into classroom practice. This is the reason for choosing a multi-strategy design for the research.

DATA

The qualitative data for the investigation are collected primarily through a series of small group interviews with open-ended questioning techniques. In these interviews, the researcher is looking to learn as much as possible from the participants, about their perceptions and the insights they have gained from their experience. It is expected that the questions asked help the participants describe into more detail their experience, in terms of what they perceived as strengths, weaknesses, as well as the challenges, and their readiness to take up learning technologies in their teaching practice.

The interviewees are assigned ID codes based on their pre- and post-survey IDs. All the interviews are translated and transcribed. Initial content codes (thematic codes) are created from the contents of the transcripts. These codes are analysed to determine the relationships between the general themes. A thematic coding approach is used to analyse the qualitative data generated from the interviews (Braun & Clarke, 2006).

APPROACH

The approach used in this method is a thematic analysis approach. According to Braun & Clarke (2006) thematic analysis is "a method for identifying, analysing, and reporting patterns (themes) within data" (p. 6). As the authors clearly describe, one of the characteristics of this approach is its flexibility of application across a range of epistemologies and theories. However, this is also viewed as a weakness because of

the lack of rigour that can be attributed to the methods used. This approach differs from that of a grounded theory in its application to a theoretical framework. Thematic analysis does not bind itself to a specific theoretical framework but there are three different methods which can be applied to it. The first is the essentialist or realist method. This reports the participants' own experiences and the reality which they live. The second is the constructionist method; this examines the way events or experiences affect the participants' discourses. The third makes use of critical realism. As discussed in the research philosophy section earlier on in this chapter, critical realism is the point of departure of the philosophy behind this thesis. In a critically realist approach, both standpoints are taken into consideration; the meaning making of the participants as they view their reality, whilst at the other end of the continuum there is the social context that impinges on the experiences which the participants live through. This is the approach this thesis takes in relation to the thematic analysis it carries out in the qualitative strategy.

METHODS

The method of interviewing uses the standardised open-ended approach. The sequence and the wording of the questions are pre-determined. The questions are open-ended and the interviewees are allowed flexibility in the way they respond. The method of analysis follows the critical realist approach using thematic analysis for the coding. In Braun & Clarke (2006), there are two methods that can be used for the coding of the data. In the inductive method, data are not coded explicitly following a research question. This thesis uses the second method proposed by the authors; the theoretical thematic analysis. In this method, the coding of the data is carried out from a specific theoretical perspective arising from the research question. In this thesis, the elements emergent from the research question involve attitudes, perceptions and reflections about the pre-service teachers' experiences.

Analysis of the coded data according to Braun & Clarke (2006) can be done at two levels; semantic and latent levels. At the semantic level the analysis of the data is kept at the surface layer as the researcher does not attempt to investigate the implications behind the discourse expressed by the participants. At the latent level, the researcher digs deeper into the meanings of the discourse by examining the underlying ideologies and assumptions that shape the semantics. At this level, the researcher

would thereby be providing an interpretation of the semantics based on the theories presented in this research. This thesis uses the latent level for the analysis of the coded data. Although the underlying thesis epistemology focuses on critical realism, the analysis of the coded data at the latent level displays a number of constructionist elements. At this level the analysis of the data focuses on the socio-cultural contexts as those that can affect the participants' experiences and thus, shape their discourse.

VALIDITY

Validity is an important aspect for both qualitative and quantitative research methodologies. However, the validity of qualitative research data has to be defined in degrees rather than as an absolute value since this is dependent on the participants' perceptions and direct observations (Cohen, et al. 2007). The approach suggested by the authors is to approach data validity for qualitative research methods from the perspective of the participants and not from the data or methods applied as for quantitative methods. Within the period of research, and for the focus group interviews, the validity will be ensured in terms of the

- descriptive accounts,
- interpretive abilities,
- validity according to theories proposed,
- generalisation in the context of the studies, and
- evaluative assignment to the results collected, adapted from Cohen et al. (2007).

Lincoln & Cuba, as cited in Cohen et al. (2007, p. 136), suggest the address of internal validity measures for a naturalistic enquiry which can also be adopted for the purpose of this research. These include:

- "Prolonged engagement in the field
- Persistent observation
- Triangulation of methods, sources, investigators and theories
- Peer debriefing
- Negative case analysis and Member checking" (Cohen et al., 2007, p. 136)

A validity checklist (Appendix 9) is performed before every group interview.

4.2.1.3 SOCIAL NETWORK ANALYTICS (SNA)

In this thesis, data was collected from the VW platform during the experiential period. This data included all forms of interaction the participants would have upon logging in the VW. All participants were aware that their interactions were being logged in the system and signed consent forms. Although the VW platform kept a log of all activities, no record of their conversations was kept and all the logs were used for research purposes. Data mined from an online learning platform generates information about the students' learning paths and directions (Buckingham Shum & Ferguson, 2012). Benefits for the use of analytics are not only for learners, educators and teaching staff, but institution administrators can use the data generated to justify the support of alternative online learning programs. Research indicates that so far analytics are being used in ways to produce early warning signals for students and staff, registering lack of student motivation or activity, and provide for higher quality design of learning courses by giving an indication of which learning activities students find most useful. The visualisation of data, is also very helpful to interpret the data sets generated by the participants as they navigate their way across the chosen context, which in this case is the VW platform.

The data that is collected in the form of learner-learned text-based interaction is represented by a series of nodes and connections. The nodes represent the learners whilst the connections represent the frequency of interactions between one learner to another or amongst a group of learners. Past research investigations in learning analytics have been shown to rely more on the actual data trails and statistical analysis than on the complex learning processes. However Buckingham Shum & Ferguson (2012) argue that the field of social learning analytics should move away from assessing the learner simply on the end product directly measurable by the scores attained in simplified tasks and instead view learning as a complex process defined by the interactions and contextual dependencies.

DATA

The data collected is in the form of a log showing the participants present as avatars in the VW, the frequency of their interactions, as well as their methods of interaction.

METHOD

The data is analysed using cRunch, an infrastructure for computationally intense learning analytics managed by the Open University's Knowledge Media Institute. cRunch is used in conjunction with R – a scripting language used for exploratory data programming. For social network analytics, a matrix is created with the incidence of interactions amongst the participants. This is then plotted as a series of nodes and relationships between the participants who interacted the most, and who were present as avatars in the VW.

4.2.2 DATA COLLECTION DESIGN PLAN

The data collected that cover both quantitative and qualitative measures include:

Table 5 - Data collection design plan

Data Collection	***What it measures***
1. Pre-test – Post-test O_1 → O_2	Knowledge, competences, and level of technology acceptance
2. Group Interviews	Perceptions and attitudes
3. Data Logs & Analytics for the VW	Presence and frequency of interactions
4. Direct Observation	Researcher reflections and personal experience

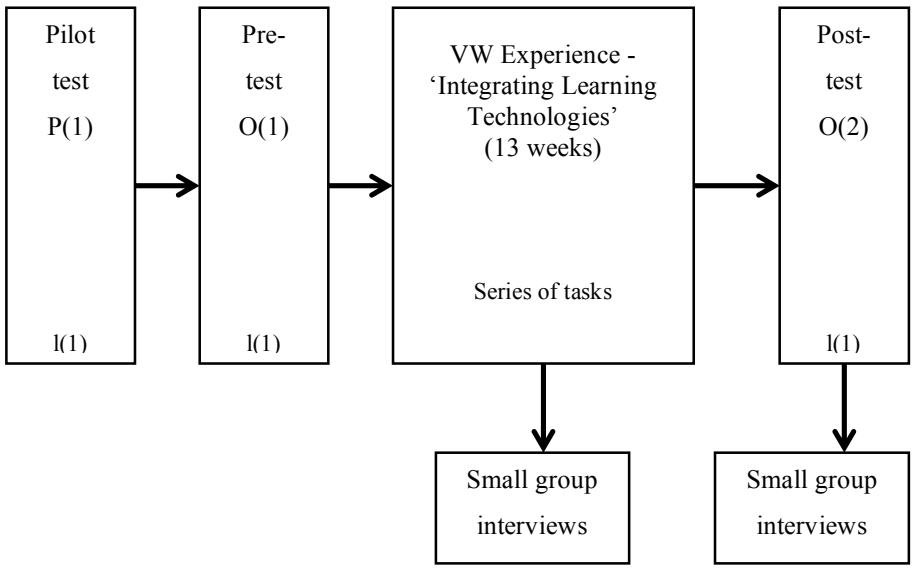

Figure 8 – Data Collection Design Plan

A group of 111 pre-service teachers (an entire cohort) following a one-year PGCE course were enrolled in a semester long study-unit between 2011-2012. This study-unit, 'Integrating Learning Technologies' was held in a 3D VW and its learning objectives are aligned to the teacher education curriculum at the University of Malta. Figure 8 shows the design plan of the investigation, starting with a pre-experience survey, moving towards the VW experience, and moving out towards the post-experience survey. Throughout the VW experience the participants complete a series of tasks.

Following this experience a group of participants are randomly selected and are asked to voluntarily participate in a focus group session. The aim of the group interviews is to understand more about the participants' perceptions and attitudes towards the broader technology uptake for learning following their VW experience.

4.2.2.1 Design Limitations

There are a number of limitations of the design which have been identified and which are listed below.

- Justifiability of causality; how can the virtual world be identified as being the primary cause of learning?
- Learner behaviour characteristics; different characteristics may lead to different attitudes and perceptions that are unrelated to the research
- Generalisations and external validity; how can this research be extrapolated to other domains? How can the data extracted from the sources be generalised to different fields?

The first two limitations deal with limitations inherent in the investigation. The limitation of causality is an important consideration. This limitation is counteracted with the inclusion of triangulation as part of the multi-strategy research. Increased sources of data assure a breadth to the analysis that would be difficult to achieve from just one source. The second limitation pertains to the participants. Since this investigation is not held inside a laboratory, with closely monitored conditions, it is very difficult to trace all the participants' meetings, and to keep track of their parallel experiences as they form throughout the rest of their teacher training curriculum.

The last limitation pertains to the extent of generalisation of the results to other domains. The generalisation of the inferences drawn depends on the validity of the data collected and the results obtained. The validity of the data is therefore given due consideration.

4.3 ETHICS

This research involves human beings and as a result of this, ethical practices are important considerations which one cannot omit.

The researcher has a dual role - designing the course, assisting and moderating throughout the course (part of the course delivery), as well as analysing the data emergent from the research. This dual role requires the establishment of a delicate balance between objectivity and subjectivity in the research carried out.

The outcome of the research is expected to have some bearing on the design of educational programs possibly in the areas of teaching, as well as continuous and professional development and lifelong learning. The 3D VW model proposed in this thesis may also have an influence on the policies and practices driving eLearning, and may serve as a reference to other higher education institutions wishing to embark on the use of VWs for teaching and learning. For these reasons, and for the ones outlined above, a meticulous and rigorous approach to research ethics has been drawn up in the form of a table (Table 1), with principles adopted and adapted from Cohen, Manion, and Korrison (2007), McMillan and Schumacher (2010) and Robson (2011). The first column identifies the ethical principle driving the research. The second column gives a brief description of the principle applied, whilst the third column illustrates how this will be put in practice during the course of the investigation.

Table 6 - Ethical considerations for the research

Ethical Principle	*Description*	*Inclusion in the Research*
Avoiding deception	This happens when participants are deceived about the nature of the research for which they volunteer, thinking they will go through an experience when in fact the experimenter plans for an entirely different experiment.	In this research, participants would be deceived if they are tricked into believing that the outcomes of the pre-test – post-test will impinge on their grades and assessment. For this purpose, participants are clearly informed about the nature of the research, assessment, as well as the purpose of the investigation.
Avoiding harm to individuals	Any harm to the individuals can be physical as much as psychological and emotional. Guidelines should be adhered to in order to avoid harm to the people volunteering for experiments.	Since this research involves an alternative learning environment, it is ensured that the participants are guided as much as possible to avoid accumulation of emotional stress during the experiment. The participants are informed that at any time during the experience, they are free to contact the researcher, either over email or face-to-face. The participants are also informed that should they feel undue pressure or stress, they can opt out from the research by not divulging any more data about their experience.
Ensuring voluntary participation	The experiment would ensure that the participants could choose not to participate after	The participants are briefed prior to the start of the 3D VW experience. During this briefing

	receiving details about the project.	session they are given an information sheet with all the details about the research, as well as a consent form, which they sign. The information sheet, as well as the consent form, contain clear indications that participation in this research is on a voluntary basis and students can opt out from divulging data about their VW experience.
Practising the right to withdraw	The participants should not, at any point, feel under pressure to continue with the experiment if they feel that they need to withdraw due to a number of reasons.	It is also clearly indicated, on both the information sheet and the consent forms, that the participants can, at any point during the investigation, choose to opt out from sharing any further data, and that the data collected about them are not made use of during the analysis.
Ensuring informed consent	The participants will be informed in detail about the elements making up the experiment.	A two-hour debriefing session is held prior to the start of the VW experience. During this session, the participants will have the opportunity to ask any questions they might have to the researcher, who is present. A presentation is also delivered where the participants will have the opportunity to view the 3D VW. An orientation session is organised so that the participants can also voice their concerns to

		the researcher inside the VW. The participants are given one week to return the signed consent forms.
Upholding privacy & confidentiality	The experiment would respect the individual's right to privacy whilst personal data are protected from sources which might not make use of them for research purposes.	For the purposes of this research, the results collected from the experience contribute towards determining the changes in attitude as a result of an active participation in the VW. Any personal data recorded are not given to 3rd parties whilst emerging results are only used for research purposes only. The data collected from online surveys, as well as from the VW data logs, are deleted as soon as they are collected to ensure data protection.
Withholding benefits from groups of participants	Participation in the experiment will not be to the detriment of the participants, vis-à-vis the individuals as well as the participants in the control group.	No group shall benefit at the detriment of the other as this research proposes a whole group experience. All the students have the opportunity and the right to attain the same learning outcomes using the VW modality for learning.
Perceived threats	Since the investigation includes participants following a formal teaching program they shall not be subject or at risk to any threats to their formal	Assessment will not be part of the investigation and independent assessment criteria will be established and agreed upon with the participants prior

	assessment.	to the start of the investigation.
Researcher influence	Researcher should not influence participants' views and beliefs throughout the experiment.	During PreVieW researcher influence should be limited by avoiding one-to-one private conversations and restricting discussion to specific content-related issues in the VW.

In order to ensure that all the participants are aware of the research, an information sheet is distributed to all students. No data is collected from any student unless a signed consent form is returned to the researcher.

The expected outcomes for the research are not expected in any way to have any bearing on situations relating to possible ethical responsibilities such as 'whistle blowing' or illegal/illicit behaviour.

4.4 PREVIEW DESIGN

This research focuses on the uses and benefits of using 3D immersive environments for determining changes in real life behaviour and attitudes

Insights into 3D immersive spaces are interpreted in terms of their characteristics and the users' own experiences. In this particular context, the 3D VW experience, PreVieW uses a platform that is chosen to fulfil a number of characteristics that lead towards participant engagement. The VW platform chosen for the environment is AvayaLive Engage[13] due to its ease of use, and its thin client interface that gives it ease of access anywhere with an Internet connection. This platform is based in the UK[14] and a server has been allocated for the purpose of the research. This VW was tested and trialled by the researcher, both as a VW creator, as well as a student in a different training course[15].

[13] Avayalive Engage platform available here: http://avayalive.com/Engage/ Last Accessed January 2014
[14] More information about case studies available here: http://www.avaya.com/usa/resources/portfolio--networking/type--case-studies/ Last Accessed May 2012
[15] This training course was organised and delivered by the Gronsted Group during July/August 2011. Amongst the training course objectives were designing for education and training in VWs. More information about this training group available here: http://www.gronstedtgroup.com/site_2011/index.html Last Accessed January 2014

In PreVieW the participants can

- see other avatars and interact verbally and via text chat (private, group or globally);
- personalise their own avatar appearance;
- view the world either as 1st person or 3rd person avatar;
- walk, sit and gesture;
- present documents (ppt, pptx, pdf, jpeg, png and gifs) with drag and drop, copy and paste, etc.;
- share desktop content and files via drag and drop, etc.;
- use a laser pointer;
- co-browse Web pages and incorporate streaming video to deliver live events;
- invite users with a URL;

The various 3D spaces which the participants can navigate through will be:

- classrooms,
- meeting rooms,
- break-out rooms,
- open spaces, and
- theatre/auditorium.

Grounded on best practices discussed in Chapter 3, PreVieW will use a technology that is accessible whilst encouraging participant encounters in the VW. The activities that are designed need to prompt the setting up of communities, whilst supporting exploration, co-creation and collaboration to solve learning missions. Game mechanics will be integrated into the VW experience by inserting quests and basic missions which the students will need to solve collectively.

4.4.1 VW FEATURES

The table below describes some of the characteristics of engagement through VWs and lists ways in which the VW platform chosen satisfies these criteria. These characteristics have been adopted and adapted by a number of researchers, including Reeves and Read (2009), Aldrich (2009) as well as de Freitas (2006), amongst others.

Table 7 - VW Features described and supported in PreVieW

VW Features	Description	PreVieW
Self-representation through Avatars	Avatars can help provide a sense of self inside a 3D space, by establishing a link between what is happening on the screen and other interaction processes, to the actual person taking decisions or communicating from the real world.	The VW platform AvayaLive will present the participants with the possibility of creating and customising their own avatar in a way, which can represent them better in the 3D space created. This avatar is persistent, throughout their duration and stay in the VW. The participants can choose navigation either in third person (meaning they can see their own avatar moving and interacting), or they can choose a first person view (meaning they can actually interact as if they are "inside" the VW.
3D Environment	3D spaces not only provide an embodiment of content and VW objects but they also provide a sense of immersion that is also dependent on the contextualised space that is created.	AvayaLive presents a series of 3D spaces that can be used to meet up, hang out, discuss, and communicate in various ways. These 3D spaces will create the environment that is necessary to foster learning through communication and collaboration, in a way that is engaging and

		stimulating for the learner.
Feedback	Continuous feedback gives an indication whether the players are on the right or wrong track and whether behaviour needs to change as a result of the feedback given. In games, feedback is a highly sought after characteristic, as failure is seen as a means of achieving success at higher level game play.	The VW designed for the purpose of this research is built on concepts of peer and expert feedback, as the participants are encouraged to participate through group discussions and informal meetings giving feedback and evaluating each other's work.
Reputations, Ranks and Levels	In game play, digital reputations are an important measure of success. The higher the ranking and the better the reputation (in the context of the game or immersive world itself), the greater the indication that the player has a good standing within the 3D immersive space context.	In the VW, reputations are established in terms of participants and experts (through the researcher and invited guests). However, throughout the discussions and informal meetings, participants are expected to assign roles in terms of meeting facilitators, presenters, note takers, etc. These are established in-world by the participants themselves on the basis of their established reputations and the way they present themselves in the groups/communities.
Marketplaces and Economies	In-world currencies most often give values to the actions and behaviours of avatars and they also reflect real world	AvayaLive does not operate in terms of currencies. However, value is given in terms of scores/points awarded on the basis of communication and interaction

	behaviour, as the economies align personal and group goals.	levels of the avatars.
Teams	Most game play is based on social interactions as teams help establish a sense of belonging reigning in any community. McGonigal (2011) characterises this sense of belonging as an important characteristic that should feature in any successful game design.	AvayaLive is mostly focused around social collaborative interactions, and uses the concept of teams to build up a stronger sense of community in the teaching/learning process. Group activities and discussions are encouraged in a bid to revive the sense of sharing and belonging that can arise from community interactions.
Parallel Communication Systems	This includes a number of modes of communication such as speech, chat and gestures. Parallel conversations (private and public) are an additional important feature which games can make use of to make the virtual environment more similar to the real physical one in terms of communication processes. Thus, a person may decide to simply hang out in a location that seems to have a number of people, speaking only to those who are in proximity. Additionally, a	AvayaLive uses a number of communication mechanisms, including private and public communication channels which participants are free to activate depending on the requirements of the 3D environment.

	player may choose to move away from a number of people discussing a specific issue and move towards someone who might have common interests.	
Competition under Rules that are Explicit and Enforced	Rules in a game are quite important to establish the parameters in which players are expected to move. Rules help players adhere to the game objectives and create an environment in which competition is fair, with conditions that have to be met by all.	Rules in AvayaLive are defined by the course objectives stated clearly at the beginning of the course. It is expected that participants follow the rules set by communication and other interaction mechanisms around which a social virtual world is built.
Time Pressure	Players are often faced with specific time frames for achieving a specific goal, or completing a quest or mission. Time pressure helps players engage with the game through excitement, triggered by endorphins in the brain most commonly associated with motivation (Koster, 2005).	AvayaLive can use different 3D environments for a set time frame. Therefore, different content material can be accessed within a specific time frame which is set to three to four weeks. Therefore, if participants wish to follow a specific section of the course, they are restricted and bound by a time frame during which that content will be active and the participants would be able to interact with it.

4.4.2 PREVIEW USER WORLDS

The VW AvayaLive Engage uses a series of 3D templates available for customisation depending on the needs and objectives of the learners and the content context. PReVieW makes use of four different worlds. A needs analysis is carried out with previous groups of PGCE pre-service teachers. In previous years, the groups of pre-service teachers manifested their lack of confidence in the use of technology for teaching and learning and their need for a transitory period when using digital tools and applications. In previous groups, pre-service teachers also demonstrated their lack of expertise and experience in 3D VWs and games. An initial brief class survey, established the participants' level of expertise and confidence in the use and application of 3D spaces. This reinforced previous assumptions about the participants' level of expertise. For this reason, PReVieW was designed to feature four different environments, which change every two to four weeks. This period of duration allows enough time for the participants to follow the course content and interact in their own time and at their own convenience.

The 3D environments change from spaces which are small and offer more guidance, to spaces that are wider, both in scope as well as layout. This offers a transitory period for the participants as they get used to their avatars and the 3D space they occupy. Moreover, the change in 3D environments allows for the participants to experience different set ups and 3D spaces, thus allowing for a greater fidelity to the real learning structures. The different environment spaces are also designed in a way as to support and facilitate different communication processes.

The content pertaining to each 3D space is available for download by the participants. However, the participants are bound by a time frame of four weeks (Table 8) to access the VW and retrieve the content, participate in the assigned tasks and participate in group/information seminar tasks. This is done in a way as to provide mechanisms so that participants follow the module continuously throughout the module duration, even though they are not restricted by specific time periods. There is also additional flexibility given into the choice of how many information seminars and tutorials they attend. This is done to investigate the level of engagement, which such a space would hold for the participants. Table 8 gives a more detailed description of each PreVieW user world.

Table 8 - 3D Environments in PreVieW

PreVieW World	Date	Content Description
#1 The Tech Store	08/10/2012-21/10/2012	Two orientation weeks in the VW, showcasing content for the study-unit *EDU4521-Integrating Learning Technologies*. Participants can walk around, whilst interacting with each other and with a variety of media related to the content. Participants do not follow specific roles. Their main objective is to experiment with the VW functions. The scope of this environment is that the participants familiarise themselves with the 3D space, and with their self-representation through the modification and customisation of their avatar. The participants are also encouraged to communicate with other avatars as well as interact with different media and content sources.
#2 The Campus	22/10/2012-18/11/2012	This 3D space is open for four weeks, and features content from the sections dealing with eLearning and Virtual learning Environments. A series of specifically designed content sources (Appendix 1) feature throughout the 3D space. Within the space, the auditorium is used for two information seminar sessions. These sessions are carried out as a result of socio-collaborative tasks assigned to the participants. Information sessions are recorded and accessible from the VW. A tutorial session is also held during these four weeks – "How to write a Seminar Paper". This tutorial is optional for the participants who wish to get additional information on how to start working on their assigned written task. Additional material is available for download.
#3 The Space	19/11/2012-	This 3D space is available for four weeks,

	16/12/2012	featuring additional content with a focus on Open Educational Resources and Social Networks for Education. Content is also redesigned to suit the needs of the VW space, allowing for more interaction and communication amongst participants and content experts. Two additional information seminars are also held during specific time periods. Another tutorial is also held – "Discussion of Seminar Paper Ideas". It is the scope of this tutorial that participants discuss their work-in-progress with their peers.
#4 The Future	17/12/2012-12/01/2013	The last four weeks of the module, are dedicated to group discussions and a presentation of the work done by the students throughout. Specific group meetings are set up, and participants are expected to contribute to group discussions.

Using the best practices emergent from recent research in the use of VWs in teacher education, PreVieW will generate activities that will help pre-service teachers generate personal VW experiences directed towards changing perceptions and attitudes towards learning technologies.

4.5 Chapter Summary

This chapter has outlined the design of this investigation based on the conceptual underpinnings driving the research. The multi-strategy design includes both the quantitative and qualitative approaches as well as a social network analysis based on user data logs from the VW. More details have also been provided into the proposed data collection, analysis and validity as well as the ethics of the research involved. The chapter has also illustrated the design of PreVieW in terms of the features represented and the content description of each VW in PreVieW. The chapter which follows will present and analyse the findings from the applied research design.

CHAPTER 5

FINDINGS & ANALYSIS

5.0 INTRODUCTION

This chapter examines the data collected from the PreVieW experience, held over 13 weeks during a 1-year Post Graduate Certificate in Education (PGCE) program for pre-service teachers. The results are presented in terms of the research questions identified in Chapter 2 of this thesis. The main research question is further subdivided into 4 research sub-questions, requiring a multi-strategy approach to data collection and analysis. Data has been collected using a pre- and post-experience survey, data logs from the VW, and focus group interviews. The analysis of this data is organised under 5 broad headings emerging from the research questions: Influence, Factors and Indicators, Social Connections, Participant Reflections and Real World Behaviour.

5.1 MAPPING FINDINGS TO RESEARCH QUESTIONS

This research poses one main question (RQ in Table 9) that requires the use of multiple strategies to construct a more in-depth perspective on how 3D VWs can be used as media to help a positive shift in technology acceptance and adoption. The main research question asks 'how the 3D VW would affect the pre-service teachers' perceptions of learning technologies, in a way that they would be better able to adopt them during teaching'.

The main question has been subdivided into four research sub-questions. This has been done in view of the multiple strategies used to collect the data. Although one approach is not mutually exclusive of the other, different questions require the use of different data collection methods to be answered and to provide an answer to the main research question. The findings are presented and analysed under the 5 headings emergent from all the research questions.

Table 9 – Presentation of Findings: relation between the sub-research questions and headings

No.	Research Question	Headings
RQ	How does the use of a 3D VW influence pre-service teachers' perceptions and behaviour towards adopting learning technologies for the classroom?	**Influence**
RQ1	What factors and indicators show a positive influence on the participants' perceptions of learning technologies?	**Factors & Indicators**
RQ2	Do the VW activities encourage more VW connections and interactions inside the VW?	**Social connections**
RQ3	What are the pre-service teachers' reflections on learning in the VW setting?	**Participant Reflections**
RQ4	How is the learning experience in the VW applied to the real world classroom practice?	**Real world behaviour**

As described in Chapter 4, the data is collected using the three methods, quantitative, qualitative and VW data logs.

5.2 INFLUENCE – RQ

The research question associated to this theme is: 'How does the use of a 3D VW influence pre-service teachers' perceptions and behaviour towards adopting learning technologies for the classroom?'

The answer to this question is that the use of a 3D VW influences the participants positively towards accepting and possibly adopting different classroom technologies.

The hypothesis that is associated to this question states that:

H1: The VW experience contributes to a positive change in the participants' self-reported perceptions about learning technologies from their initial views.

The data collected in relation to this question were in the form of a pre- post experience survey, where the participants' gave a measure about their self-reported changes in attitude using a 5-point Likert scale. This is described in more detail in Chapter 4 of this thesis. The questions in the survey instrument use six measures. These are described in Table 10. The questions refer to 'Internet applications' as a broad term which covers technologies, tools and media that use the Internet. This term is used as part of the discourse throughout this PreVieW experience and the 'Learning Technologies' study-unit (See Appendix 1 & 2). The use of the pre- post- experience surveys also aims to reduce threats to internal validity in terms of statistical regression and instrumentation. Using a validated instrument avoids unreliable testing, and any scoring regression.

Table 10 - Measures of the pre- and post- experience instrument for self-reported perceptions about learning technologies

Measures	No of Items *Pre*	*Post*	Description
Perceived usefulness	4	6	The questions under this heading address the issues related to perceptions about improved performance at the workplace and the use which Internet-related applications could have in teaching.
Perceived ease of use	3	6	The set of questions falling under this heading measure the participants' perceived efforts and the aptitudes with which they handle applications and Internet-based media.
Attitude	5	4	These questions relate to the perceived sense of enjoyment which the participants feel every time they interact with Internet-based applications.
Behavioural intention	2	4	The questions falling under this heading give a measure to the participants' current usage of Internet-based applications and media, and their projected future usage for their work.
Perceived complexity	1	3	These questions attempt to give a measure to the participants' self-reported beliefs in their abilities to handle Internet-based applications. It is expected that the higher the complexity which they report, the lower their self-beliefs about their capabilities would be.
Voluntariness	1	3	The set of questions in this heading gives a measure to the participants' reported compulsion in using the Internet for their teaching-related work.

Since the pre- and post- surveys consisted of a different number of questions within the same heading structures, a mean of the values for each heading is taken into consideration during the analysis.

For hypothesis **H1**, a paired-sample t-test analysis was carried out on the data to compare mean rating scores before (pre-) and after (post-) the 3D experience.

The null hypothesis specifies that the mean rating scores before and after the 3D experience are comparable. This hypothesis is accepted if the p- value exceeds the 0.05 level of significance.

The alternative hypothesis specifies that there is a significant change in the mean rating scores before and after the 3D experience. This hypothesis is accepted if the p-value is less than the 0.05 criteria.

H_0: There is no shown change in self-reported attitude towards technology following the 3D VW experience.

H_1: There is a significant change in self-reported attitude towards technology following the 3D VW experience.

Table 11 - Paired samples statistics for the pre- post- experience survey (n=74[16]) for technology perceptions

Indicators	Mean	Std. Deviation	P-value
Perceived usefulness (Post)	3.64	0.446	0.55
Perceived usefulness (Pre)	3.60	0.399	
Perceived ease of use (Post)	3.40	0.559	0.16
Perceived ease of use (Pre)	3.31	0.526	
Attitude (Post)	3.25	0.712	<0.05
Attitude (Pre)	2.67	0.466	
Behavioural intention (Post)	3.47	0.578	<0.05
Behavioural intention (Pre)	2.79	0.707	
Perceived complexity (Post)	1.86	0.655	<0.05
Perceived complexity (Pre)	3.65	0.584	
Voluntariness (Post)	1.69	0.921	<0.05
Voluntariness (Pre)	2.62	0.735	

In Table 11 the mean rating scores for 'perceived usefulness' and 'perceived ease of use' increased marginally such that the change was not found to be significant since their respective p-values (0.55) and (0.16) both exceed the 0.05 level of significance. For both of these indicators, the null hypothesis H_0 is accepted and this means that there was no significant change in the participants' self-reported views on the 'perceived usefulness' and the 'perceived ease of use'. On the other hand, the mean rating scores for 'attitude' and 'behavioural intention' increased significantly, whereas the mean rating scores for 'perceived complexity' and 'voluntariness' decreased significantly since all four p-values are less than the 0.05 criterion.

The null hypothesis is rejected whilst the alternative hypothesis is accepted for the values obtained from 'attitude', the 'behavioural intention', the 'perceived complexity' and the 'voluntariness'. These results show that whilst the participants' perceptions about the usefulness of learning technologies and their ease of use were not subject to a significant change from before and after the VW experience, attitude, behaviour towards, the attributed complexity and the compulsory use of the Internet were subject to a significant positive change following the VW experience. This be can possibly be explained by the qualitative data, where during the interviews it

[16] Although the full sample size of the population was 111, only 74 participants responded to both the pre- and the post- experience surveys.

transpired that participants may have equated the term technologies to VWs during the pre- and post experience survey. In fact many of the participants interviewed replied that whilst learning in a VW had a definite impact of them, the local school technology infrastructure made it impossible for them to adopt VWs for teaching.

A significant difference in the mean score for the questions related to the 'attitude towards', and 'behavioural intention', show that the participants changed their opinions following their VW experience. These show that the participants find the experience significantly more enjoyable, and they are also significantly inclined towards increased use of Internet-based applications in their teaching. The items on perceived complexity and voluntariness in using the Internet were reverse coded since the items gave a measure of negative tendencies, for example: 'When I use the Internet, I find it difficult to integrate the results into my existing work'.

Although the above analysis shows that there is a significant positive change in attitude, behavioural intention, perceived complexity and voluntariness following PreVieW there is no clear indication of why this change was brought about. The research sub-questions below attempt to gain more insight into the factors as well as the VW interactions that might have brought about such change. Additional sub-questions use qualitative data to shed light on the participants' reflections from PreVieW and how they applied their knowledge to their class teaching practice following their VW experience.

5.3 Factors & Indicators – RQ1

In relation to perceptions this thesis asks the following question, 'What factors and indicators show a positive influence on the participants' perceptions of learning technologies?'

The hypothesis associated with this research question uses a quantitative approach for the analysis:

H2: Contrary to personal perceptions, factors such as age, gender and field of studies have no significant effect on the participants' self-reported perceptions of learning technologies.

For hypothesis **H2**, which states that factors such as gender, age and field of studies do not have a significant effect on technology acceptance factors, the analysis makes use of one-way ANOVA test to compare mean scores between three independent groups according to gender, age[17] and field of study[18]. Tests were carried out on the data, using SPSS to ensure no significant outliers and that the dependent variable is normally distributed for each category of the independent variable. The null hypothesis specifies that the mean dimension scores vary marginally between the groups and is accepted if the p-value exceeds the 0.05 level of significance. The alternative hypothesis specifies that the mean dimension scores vary significantly between the groups and is accepted if the p-value is less than the 0.05 criterion.

H_0: There is no significant difference between self-reported perceptions towards technology and gender.

H_1: There is a significant difference between self-reported technology perceptions towards technology and gender.

Table 12 - Correlations between self-reported technology perceptions and gender (n=74[19])

Dimension	Gender	Mean	Std. Deviation	95% Confidence Interval for Mean		F	P-value
				Lower Bound	Upper Bound		
Perceived usefulness	Male	3.69	0.416	3.48	3.89	0.270	0.61
	Female	3.62	0.458	3.50	3.74		
Perceived ease of use	Male	3.31	0.534	3.04	3.57	0.723	0.40
	Female	3.43	0.567	3.28	3.59		
Attitude	Male	3.01	1.100	2.47	3.56	2.676	0.11
	Female	3.33	0.524	3.19	3.47		
Behavioural intention	Male	3.22	0.612	2.92	3.53	4.433	0.04
	Female	3.54	0.550	3.40	3.69		
Perceived complexity	Male	1.78	0.471	1.54	2.01	0.375	0.54
	Female	1.89	0.706	1.70	2.08		

[17] The population was divided into three age categories: 21-25 years, 26-35 years and 36-55 years. These age groups reflected the overall participant age in PreVieW.
[18] The participants in PreVieW registered in PGCE specialised in 16 subject areas namely Maths, English, History, Social Studies, Religion, Maltese, PSD, Computing, French, German, Science, Music, Spanish, Italian, Geography, Business Studies. These have been categorised into three groups: humanities, languages and sciences.
[19] Post-experience survey only.

Experience	Male	3.11	0.758	2.73	3.49	0.140	0.71
	Female	3.18	0.636	3.01	3.35		
Voluntariness	Male	1.74	0.728	1.38	2.10	0.061	0.81
	Female	1.68	0.981	1.42	1.94		

Table 12 indicates that there are marginal variations between the groups and shows no significant difference. This means that the null hypothesis is accepted for all the dimensions except for the 'behavioural intention' whilst the alternate hypothesis is rejected. The p-value exceeds the 0.05 criterion for all the dimensions except for the 'behavioural intention'. This means that for six out of the seven dimensions listed as part of the technology acceptance model, there is no significant difference between self-reported attitudes and gender. This result could be due to a small sample size.

The same result is obtained for the second independent group (age). The p-value which exceeds the 0.05 level of significance for all the dimensions except for the 'behavioural intention' rejects the alternate hypothesis in favour of the null hypothesis. The null hypothesis states that there is no significant difference between self-reported attitude towards technology and age.

H_0: There is no significant difference between self-reported technology perceptions towards technology and age.

H_1: There is a significant difference between technology perceptions towards technology and age.

Table 13 - Correlations between self-reported technology perceptions and age groups (n=74)

Dimension	Age	Mean	Std. Deviation	95% Confidence Interval for Mean		F	P-value
				Lower Bound	Upper Bound		
Perceived usefulness	21-25 years	3.63	0.444	3.51	3.76	0.630	0.54
	26-35 years	3.57	0.488	3.29	3.85		
	36-55 years	3.79	0.396	3.46	4.12		
Perceived ease of use	21-25 years	3.42	0.454	3.29	3.55	0.079	0.92
	26-35 years	3.36	0.874	2.85	3.86		
	36-55 years	3.38	0.569	2.90	3.85		
Attitude	21-25 years	3.25	0.706	3.06	3.45	0.487	0.62
	26-35 years	3.13	.887	2.61	3.64		
	36-55 years	3.44	.347	3.15	3.73		
Behavioural intention	21-25 years	3.51	.491	3.38	3.65	2.436	0.10
	26-35 years	3.18	.846	2.69	3.67		
	36-55 years	3.66	.421	3.30	4.01		
Perceived complexity	21-25 years	1.83	.700	1.64	2.03	0.587	0.56
	26-35 years	2.02	.480	1.75	2.30		
	36-55 years	1.75	.636	1.22	2.28		
Experience	21-25 years	3.21	.536	3.06	3.36	0.899	0.41
	26-35 years	3.14	.949	2.59	3.69		
	36-55 years	2.88	.835	2.18	3.57		
Voluntariness	21-25 years	1.64	.824	1.41	1.87	0.285	0.75
	26-35 years	1.83	1.370	1.04	2.62		
	36-55 years	1.79	.589	1.30	2.28		

Table 13 shows that there is no significant difference between the participants' self-reported perceived usefulness, ease of use, attitude, complexity, experience and voluntariness in using learning technologies and their age groups.

H_0: There is no significant difference in self-reported attitude towards technology and field of study.

H_1: There is a significant difference between self-reported attitude towards technology and field of study.

For the third independent group, field of study, the p-value exceeds the 0.05 level of significance for all the dimensions related to technology acceptance. This means that the null hypothesis is accepted and that there is no significant difference between the

field of study and the level of self-reported perceptions towards technology acceptance and adoption in the classroom.

Table 14 - Correlations between self-reported technology perceptions and field of study (n=74)

Dimension	Field of study	Mean	Std. Deviation	95% Confidence Interval for Mean		F	P-value
				Lower Bound	Upper Bound		
Perceived usefulness	Humanities	3.65	.486	3.45	3.86	0.035	0.97
	Languages	3.62	.447	3.45	3.79		
	Sciences	3.64	.416	3.45	3.83		
Perceived ease of use	Humanities	3.44	.471	3.24	3.64	2.008	0.14
	Languages	3.52	.470	3.34	3.70		
	Sciences	3.21	.717	2.88	3.53		
Attitude	Humanities	3.19	.708	2.89	3.49	1.211	0.30
	Languages	3.41	.532	3.20	3.61		
	Sciences	3.11	.903	2.70	3.52		
Behavioural intention	Humanities	3.40	.571	3.15	3.64	0.632	0.53
	Languages	3.56	.480	3.38	3.74		
	Sciences	3.42	.709	3.09	3.74		
Perceived complexity	Humanities	1.93	.538	1.70	2.16	2.082	0.13
	Languages	1.98	.695	1.71	2.24		
	Sciences	1.62	.685	1.31	1.93		
Experience	Humanities	3.08	.717	2.78	3.39	0.305	0.74
	Languages	3.17	.602	2.94	3.40		
	Sciences	3.24	.700	2.92	3.56		
Voluntariness	Humanities	1.85	.810	1.51	2.19	0.570	0.57
	Languages	1.57	.963	1.21	1.94		
	Sciences	1.68	.997	1.23	2.14		

Further analysis shows that three components have been identified as contributing to 70% of the variance in the data skewness [Appendix 8]. For the component with the greatest percentage of variance, the variables which contribute to its loading have been identified as being the ‘perceived ease of use’, ‘behavioural intention’, ‘attitude’, and ‘experience’.

In response to RQ1, 'What factors and indicators show a positive influence on the participants' perceptions of learning technologies?' the quantitative analysis carried out on the survey data collected before and after the experience shows that:

A. There is a significant change in self-reported perceptions between the pre- and post- experience test following the VW experience ($p>0.05$) for 'attitude', 'behavioural intention', 'perceived complexity' and 'voluntariness'. This indicates that PreVieW had an impact on the participants' perceptions towards the adoption of learning technologies in the classroom;
B. There is no significant change in self-reported perceptions between the pre- and post- experience test following the VW experience ($p<0.05$) for 'perceived usefulness' and 'perceived ease of use' to learning technologies. This could be due to the fact that as reported in in the qualitative findings, the participants thought of learning technologies in terms of the 3D space, and felt that they could not use technologies such as 3D VWs in the physical classroom setting.
C. There is no significant difference in self-reported perceptions and gender with the exception of the behavioural intention ($p=0.04$);
D. There is no significant difference for self-reported perceptions and age as well as field of study.

These results do not attempt to explain the reasons behind the assertions. They do, however, confirm null hypotheses 1 and 2. These results are discussed further in Chapter 6.

5.4 Social Connections – RQ 2

The research question associated with this theme asks: Do the VW activities encourage more VW connections and interactions inside the VW?

The answer to this question is provided through the mapping of the planned learning activities with the text-based interactions that have been analysed using social network analysis (SNA).

The data logs obtained from the VW show the interactions of the learners with the non-player characters and content objects in the VW as well as with the other avatars. In PreVieW the participants could interact in a number of modalities. They could use a voice chat amongst private individuals, a voice chat amongst a group of individuals, a voice chat with the whole group in the VW, text chat amongst private individuals, text chat amongst a group of individuals and a text chat with the whole group in the VW. A log of all the participants' interactions was collected for the period October 2012-January 2013. For the purpose of this thesis only the data logs collected between October-December 2012 will be considered.

RStudio[20] was used to analyse the data logs and map out a social network graph of the participants' text-based interactions. Text-based interactions were amongst the most popular form of interaction, though in some instances conversations between participants were also logged in. However, these were quite limited mostly because of technical and logistical issues. Technical issues involved limited bandwidth which would limit the audio capabilities from the client's side disabling communication using voice.

The data collected from the logs are stored using the following headings:

date	time	c-ip	cs-username	cs-userid	cs-sessionkey	cs-method	cs-uri-stem	cs-status	cs-coords	cs-comment

Each heading stores specific information for every VW log. Each entry is categorised with a date, time, IP address, the user name, a unique user ID. Every time a user logs in a session key is generated. Every action the user performs in the VW is registered under cs-method in addition to the VW coordinates for the location of the user for that method. An example of such a method is 'PROXIMITY_TEXTCHAT'. The system also generates a comment which describes the action of the user inside the VW. An example of a comment is "ID X sent 3 characters to ID Y". The method indicates what interaction was held between the users, whereas the comment gives a description of who was interacting. Participant interactions were recorded during the months of October, November and December 2012. In January 2013, no activity was recorded.

[20] RStudio is an integrated development environment for R. R is a free software environment for statistical computing. It allows for data manipulation, calculation and graphical display. RStudio is available online: https://www.rstudio.com [Last Accessed: March 2014].

Figure 9 below, shows the number of participant text-based interactions (number of postings) during the days of the month of October 2012. Specific days registered peaks for interactions during specific days. These happened during planned group learning activities, such as seminar sessions and group tasks.

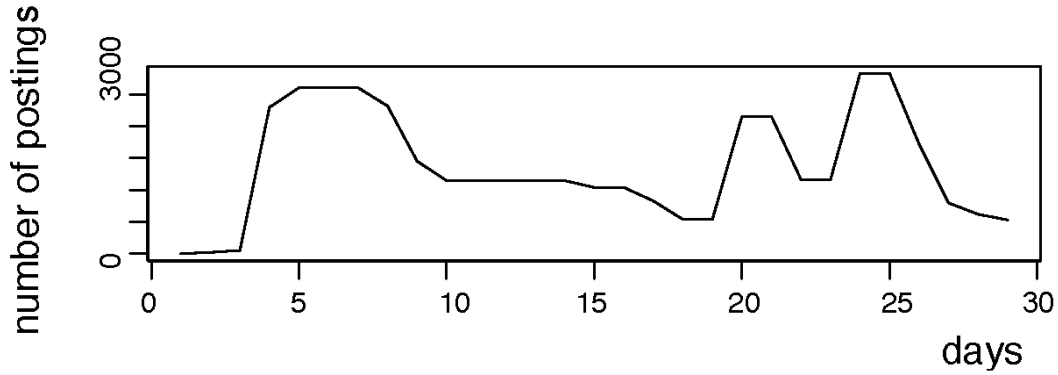

Figure 9 - Number of group text-based postings (chats) during the month of October 2012

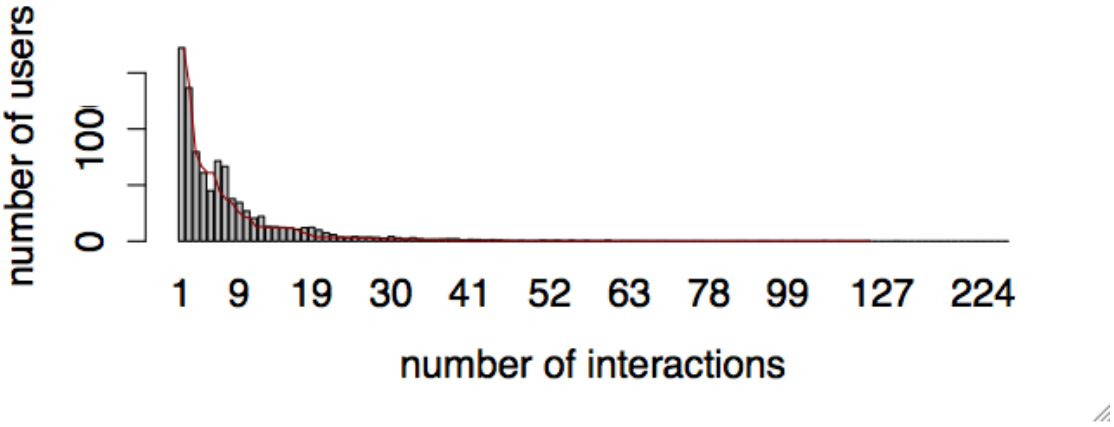

Figure 10 - Number of users (participants) versus the number of group text-based interactions held during the month of October 2012

Figure 10 above shows the number of interactions for the participants in the study. This shows that the 50-100 participants had a limited number of interactions (<9) during the month of October 2012. Figure 11 shows a social network graph based on the group-based text chats of the participants during the month of October 2012. The raw data obtained from the log file are then converted into an incidence matrix of user interactions. Since the interactions between the users are quite numerous, different analyses are carried out for the different methods. The two methods chosen are 'proximity text chat' (group-based text interactions) and 'private text chat' (individual

text interactions). The social network graphs for the private text chat interactions are presented in Appendix 7. The script shown below is used by RStudio to run the social network analysis on the user interactions. It gathers data from the log headings to be able to plot them in a graph based on their frequency of interactions.

```
# SNA – Social Network Analysis

library(network)
library(sna)

u2u = matrix(nrow=length(users),
ncol=length(users), 0 )
rownames(u2u) = users
colnames(u2u) = users

# loop through every entry in the log file
for (i in 1:nrow(data)) {
  if (data[i, "cs.method"] == "PROXIMITY_TEXTCHAT")
{
    from = as.character(data[i,"cs.username"])
    torealname = gsub( "(.*) characters to (.*)",
"\\2", as.character(data[i,"cs.comment"]), perl=T)
    if (grep(" ", torealname)) { to = gsub("\\W",
"_", torealname)  } else { to = torealname}
    u2u[from, to] = u2u[from, to] + 1
    print(paste("found message from ", from, " to
", to, "(realname: ", torealname,")"))
  }
```

The visualisation of the resultant graph is then plotted using:

```
plot(net, vertex.col=cs[1], edge.col=linecolours,
displaylabels=T, arrowhead.cex=0.4,
displayisolates=F, vertex.sides=40, usecurve=T,
edge.curve=.03, edge.steps = 100, loop.steps =
100)
```

The resultant graph displays users as nodes and their interactions as connections between the nodes. RStudio takes into account the frequency of interaction of each user, and the user names of those he/she is interacting with and plots them in graphs such as that in Figure 11.

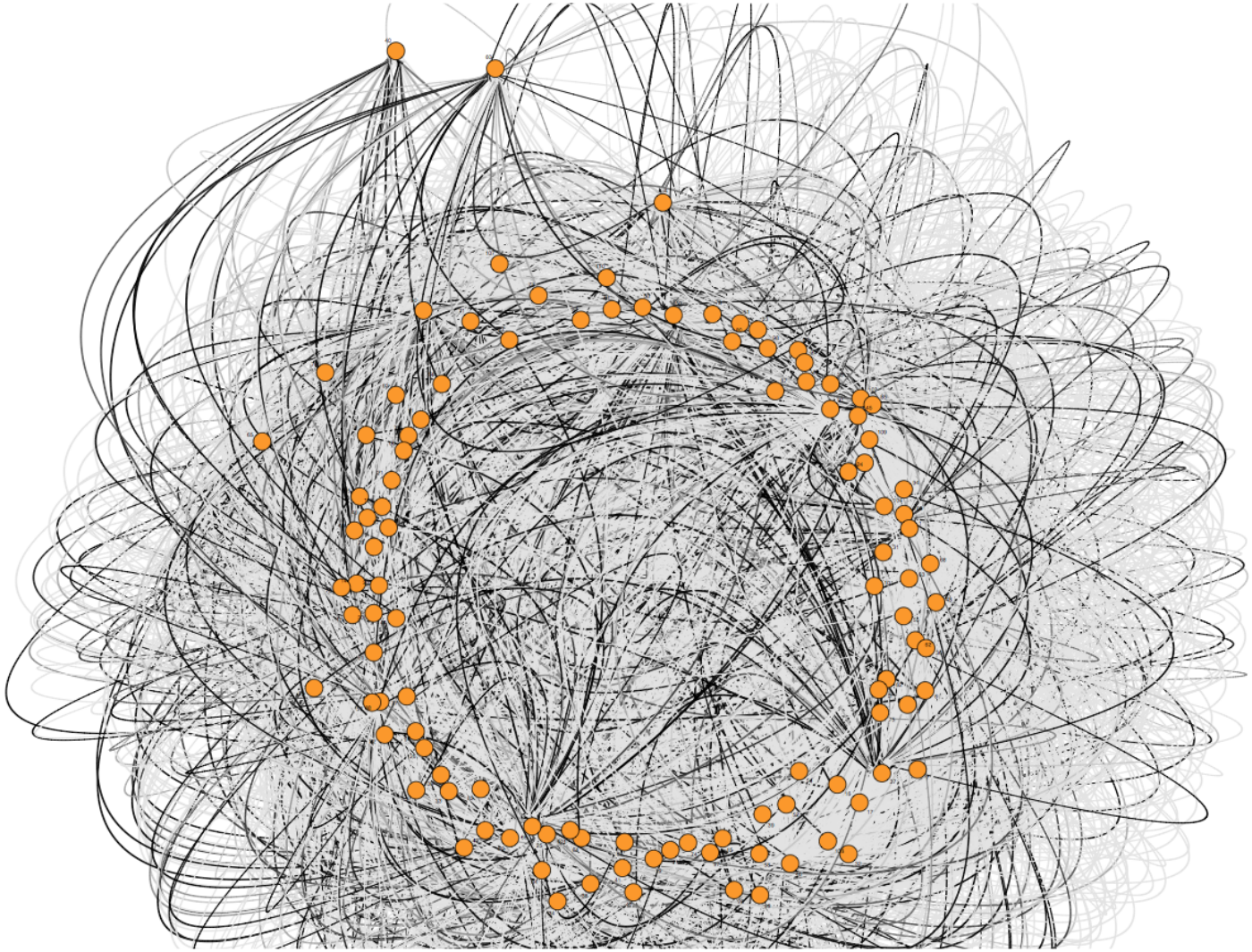

Figure 11 - A social network analysis graph using RStudio for group-based text chats between participants during the month of October 2012

Figure 11 is the resultant graph that shows a dispersion of the interaction amongst participants. The participants are shown as (orange) nodes, whereas the connections between the nodes indicate the interactions between them. A strong weight of the connecting lines indicates a greater number of interactions between the participants.

From this graph, it can be observed that there is not one node, which carries the highest prestigious score. A node with a high prestigious score would feature in the centre of the graph. This means that throughout the overall month of October 2012, the researcher, who is also included in the nodes, is not given any extra prominence in the course of the participant discussions but was involved in the participant discussions as equal. This indicates that the text-based conversations were not over-ruled by the researcher but were conducted by the participants involved.

Two outlier nodes can be identified from the graph. These nodes at the edge of the graph indicate that whilst they were involved in text-based interactions, the participants showed limited reciprocation in their communication.

Figures 12 and 13 show the social network analysis graph for the months of November and December 2012. As can be shown from the graphs the amount of nodes in November 2012 decreased from those in October 2012, whilst the number of outlier nodes increased. This means that there were fewer participants present in the VW than the previous month and there were more participants who did not reciprocate the group text-based communication. This is shown by the increased number of outlier nodes present. However, the graph visualisation also shows that the participants in the social network formed inside the VW, were interacting more and with more frequency of exchange. This is indicated by the darker weight of the lines connecting the nodes together. The darker the lines, the more frequent the text-based interactions would be. This means that although there were fewer participants, with the exception of the outliers, those who were present in the VW interacted more than in the previous month.

In December 2012, the number of nodes showing the number of participants interacting in the VW decreased from the previous months. However, the number of outliers remained unchanged from that of November 2012.

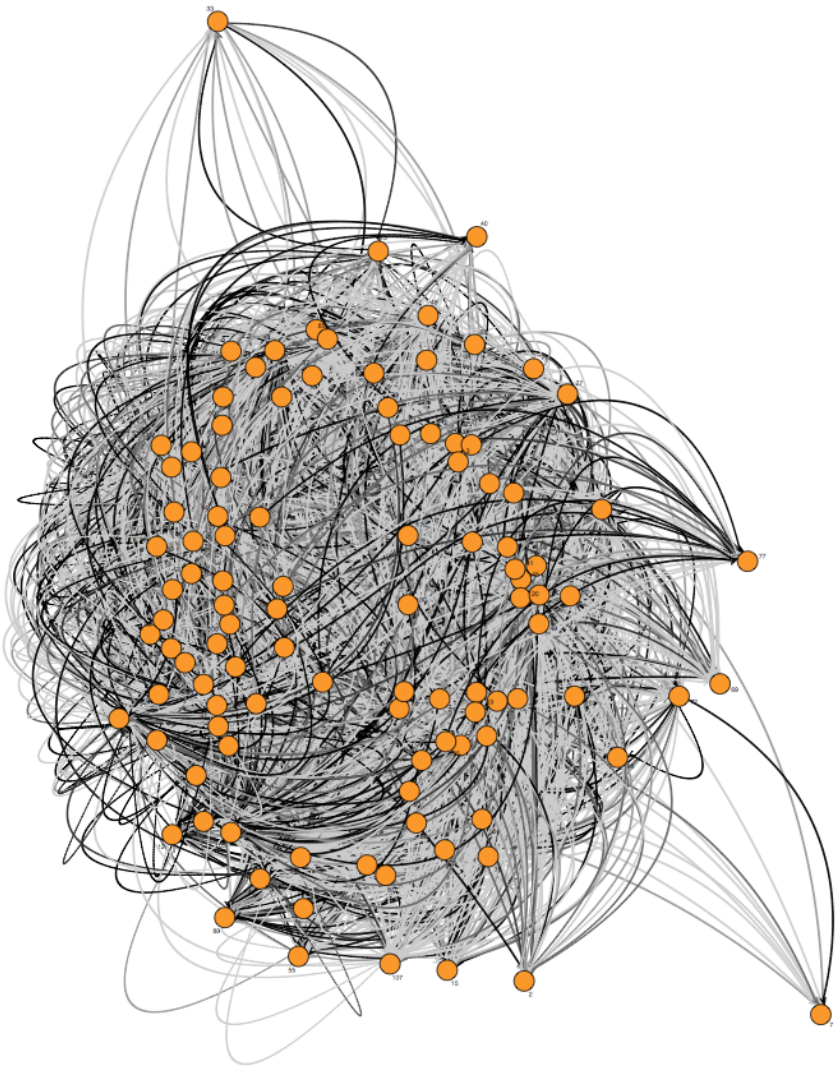

Figure 12 - A social network analysis graph using RStudio for group-based text chats between participants during the month November 2012

Figure 13 - A social network analysis graph using RStudio for group-based text chats between participants during the month December 2012

Figures 12 & 13 also show a marked distinction in the clustering of the participants during interactions. Whilst for October 2012 the nodes are dispersed equally in a circle, in November 2012 there is a marked clustering between groups of participants. This shows that specific groups of participants developed small communities in which they could interact using group text chats. In December 2012, there is one marked cluster of nodes and more dispersion in the other nodes. Small clusters, indicating small groups of interacting participants, can be identified but the distinction is not clearly marked.

Since participation and interaction were more clearly more marked during October 2012, the social network analysis for the month was also broken down on a weekly basis to identify any patterns emerging from the group interactions. These patterns show the dynamics of the evolution of the communities inside the VW during PreVieW.

Figure 14 - A social network analysis graph for group text chats between participants during Week 1 in the month of October 2012

Figure 14 above shows that during the first week in October 2012, the participants were interacting amongst each other without any noticeable clusters. Although a number of participants spoke more frequently to each other, as shown by the more pronounced weighting of the connecting lines between some nodes as opposed to others, the number of outliers indicates that participants were not exchanging interactions equally. This means that whereas some participants were communicating, others were not reciprocating.

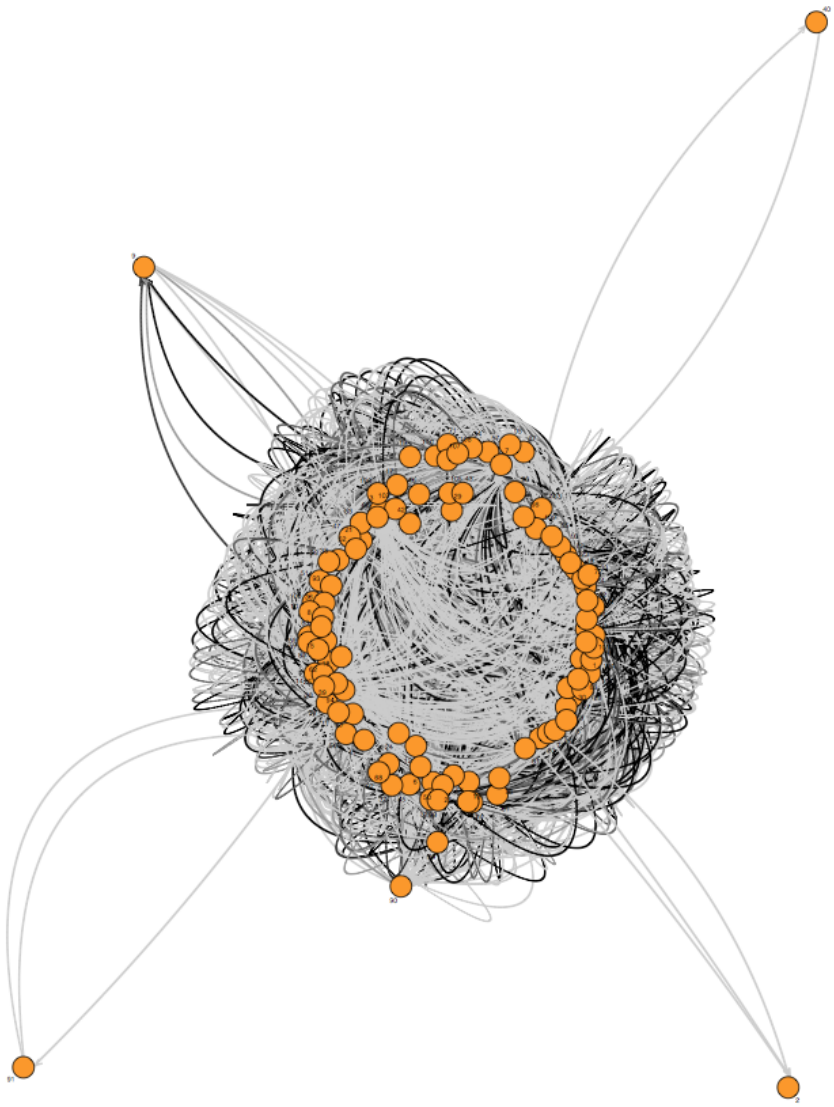

Figure 15 - A social network analysis graph for group text chats between participants during Week 2 in the month of October 2012

Figure 15 shows that during the second week in October, more homogeneity among the whole group was achieved as more participants interacted, and with more frequency. The thickness of the connections between the nodes indicates that there were more reciprocated text-based exchanges between the participants as the number of outliers decreased considerably.

Figure 16 - A social network analysis graph for group text chats between participants during Week 3 in the month of October 2012

The figure above (Figure 16) indicates that there were some movements in the dynamics of the formation of clusters between the participants for the group text chats in the VW experience. It is also apparent that whilst there is a cluster of participants who feature at the centre of the graph and therefore with the highest prestigious scores, the number of overall participants has decreased. Various small communities seem to have formed in this third week. According to the VW experience timeline, during the second week in October, participants were scheduled to meet in the world for an initial meeting and handing out of tasks. This would explain the dynamics of the group connections during the week. During the third week the participants were left to freely connect, explore and experiment with the tasks in the world without any set dates or times. The graph shows that although fewer participants logged in the VW, there was more clustering in the connections established.

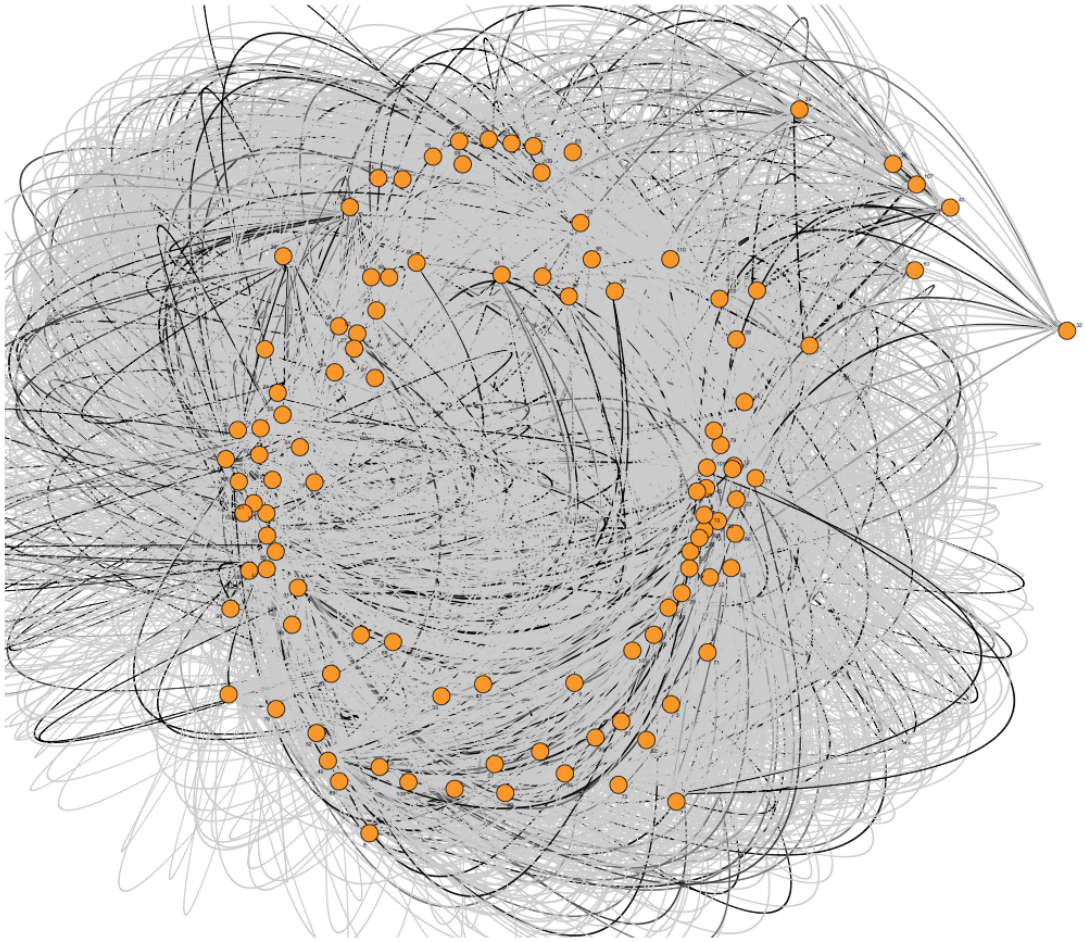

Figure 17 - A social network analysis graph for group text chats between participants during Week 4 in the month of October 2012

During the fourth week of PreVieW the number of connections established increased again. During this week, the participants were assigned to present the work they did in their group-based tasks in a virtual information seminar. The graph shown in Figure 17 shows that the number of outlier nodes decreased from the previous week. This means that there was an increased exchange of communication between more participants in the VW. In parallel to the group text-based discussions, participants also engaged in private text chats. Although the discussions were not recorded, the data logs from the VW platform show that participants participated more in group-based discussions rather than private text chats. However, the visualisation of the social network analysis for both types of interactions provides useful insights into the connections established between the participants during the experience. A more detailed set of private-text based visualisations are discussed and presented in Appendix 7.

The hypothesis which is associated with the results shown by the social network graphs presented and which show the participant presence through their group text-based interactions is:

H3: Socio-collaborative activities inside the VW are positively related to increased participant interactions.

The null hypothesis specifies that the planned activities in the VW do not have a significant effect on participant interactions inside the VW. This hypothesis is accepted if there is no difference in participants' text-based interactions during the experiential period.

The alternative hypothesis specifies that there is a significant increase in the number of participant interactions inside the VW as a result of planned socio-collaborative activities. This hypothesis is accepted if there is an increase in the participants' text-based interactions during the weeks in which socio-collaborative activities are carried out as compared to other weeks where no activities are planned.

H_0: There is no difference in participants' text-based interactions during the weeks in which socio-collaborative activities are carried out, as compared to other weeks where no such activities are planned.

H_1: There is a significant increase in participants' text-based interactions during the weeks in which socio-collaborative activities are carried out, as compared to other weeks where no such activities are planned.

Although the persistent nature of the VW enables a personalised and flexible learning environment, a number of activities built around a socio-collaborative modality were planned for Week 2 and Week 4 during the month of October 2012 [Appendix 3 & 4]. Figures 15 and 17 show a distinct increase in participant group text chats as compared to Week 1 and Week 3 of the same month.

The social network analysis shows that during the days when group information seminars were held, the group text-based interactions increased significantly.

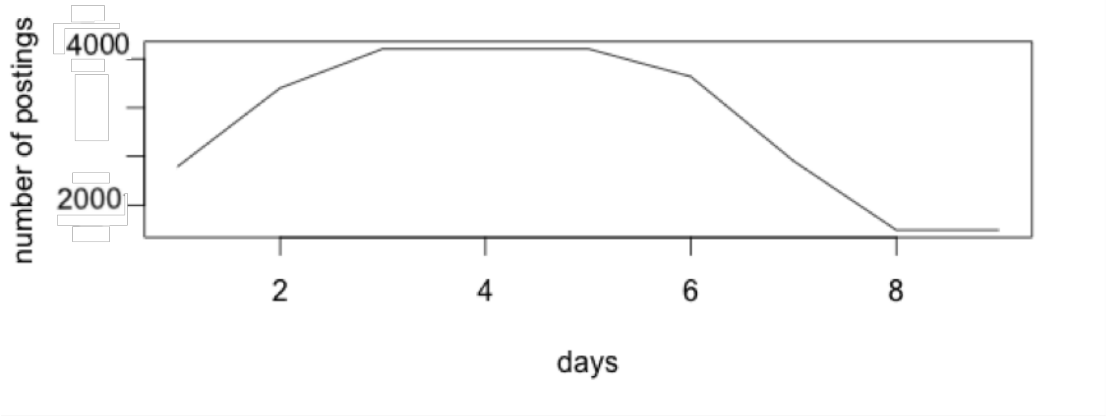

Figure 18 - Number of postings over days in October Week1

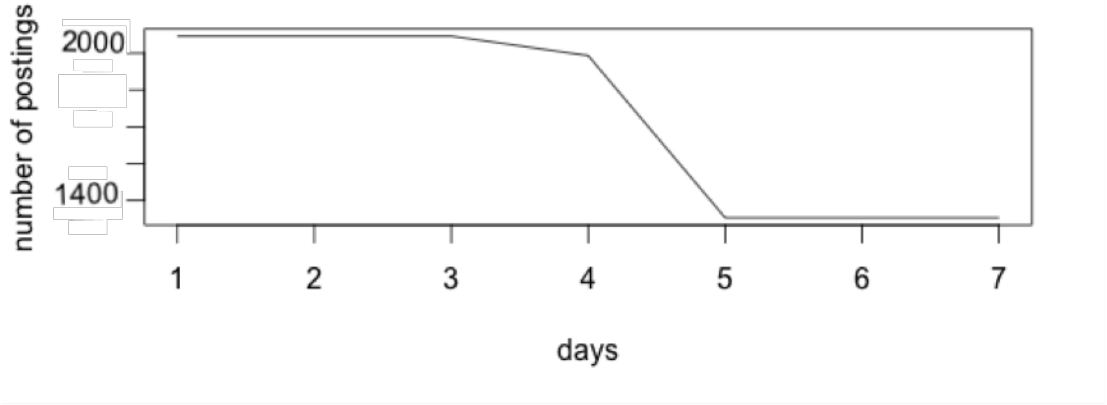

Figure 19 - Number of postings over days in October Week2

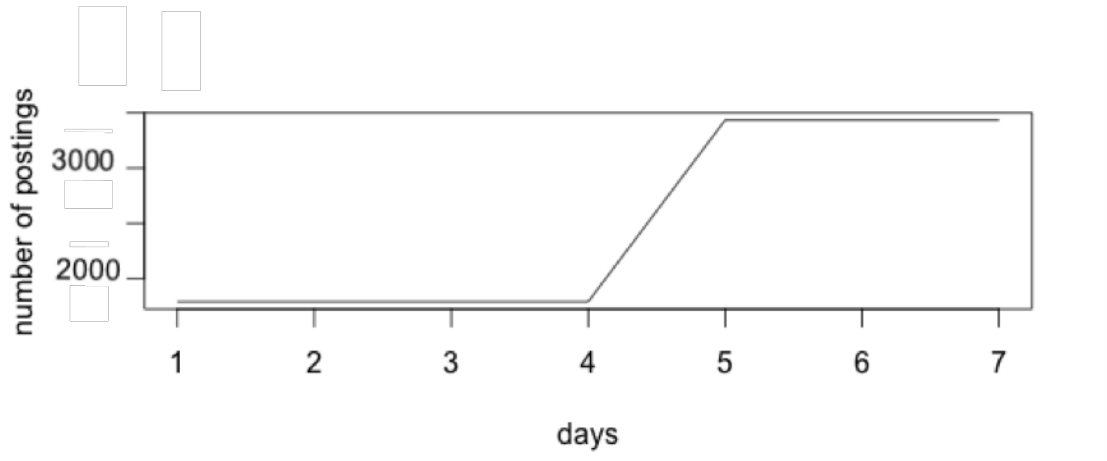

Figure 20 - Number of postings over days in October Week3

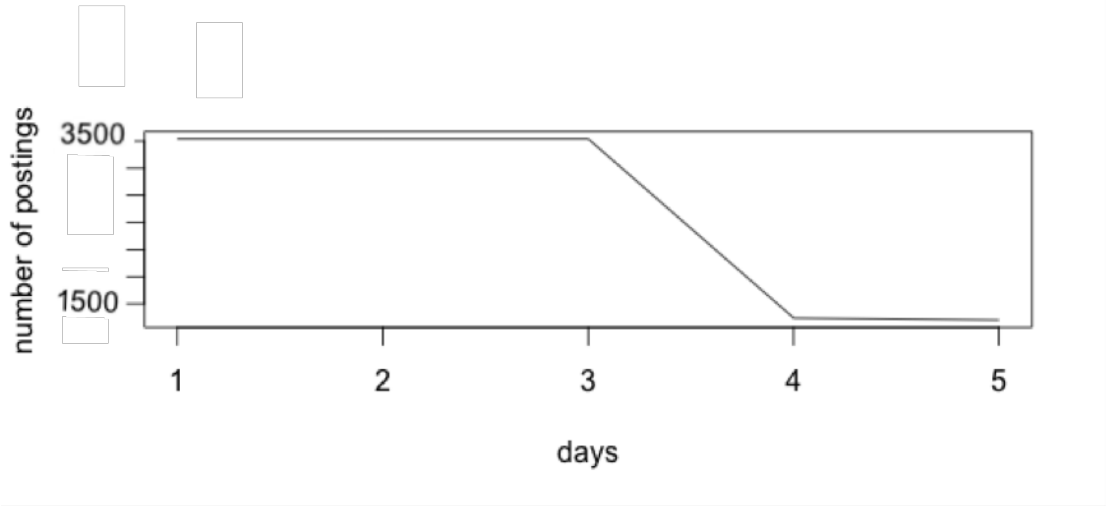

Figure 21 - Number of postings over days in October Week4

As shown by the graphs and figures above (Figures 18-21) and the timeline of the planned activities (Appendix 3), there is a strong correlation between the social networks formed and the activities held. During the time there was a set activity (Week 2 and Week 4) the text-based activities in the VW increased considerably. This further corroborates the hypothesis that planned socio-collaborative activities would increase communication between participants in the VW.

The significant increase in the group text-based interactions thus rejects the null hypothesis and accepts the alternative hypothesis which states that the increased participant interaction is a result of planned activities of a socio-collaborative nature.

The figures show a decline in the use of the VW, especially during the periods where no formal tasks or quests were given to the participants for two weeks in October 2012. Despite the fact that the same number of learning activities were planned for the three months, the results show a decline in the interactions during the months of November 2012 and December 2012, as compared to the month of October 2012. The results also indicate that although at the start of PreVieW the researcher had the more prestigious node featuring at the centre of the social network graphs after Week 2 of the experience, this node moved towards the circumference of nodes holding the participants' measure of interactions. This indicates that for the group-based interactions after Week 2 of PreVieW, the researcher was no longer the participant with the greatest number of interactions (sent and received messages).

This is an important consideration in terms of the learning theories and models applied to the design of the VW. According to the conceptual underpinnings discussed in Chapter 4 of this thesis, such experiential and socio-collaborative learning theories decrease the teacher's central role in learning and place more learning responsibility on the learner as he/she takes up a more active position.

The results indicate that for the text-based interactions, the researcher, who was also the tutor for PreVieW, was no longer a central connecting figure.

5.4.1 Mapping of Pre- Post- Survey Results to Social Interactions

Together with visualisations, RStudio generated a matrix with the participants in rows and columns. Each cell contains the number of interactions held between the participants. This was followed by an analysis using the Bayesian Information Criterion to determine how many participants interacted the most, and how many interacted the least (Appendix 8). BIC identified one cluster of participants with significant number of interactions, in the form of sent and received group text-based messages (Cluster 1).

Table 15 - Cluster values emergent from BIC

		Sample Size	Percentage
Cluster	1	17	15.3%
	2	94	84.7%
Total		111	100.0%

In Table 16, 17 participants were clustered (15.3%) as being those who sent and received more group-based text chat messages than the 94 respondents (84.7%) in Cluster 2. The cluster of individuals sending more text chat messages have been identified as those carrying ID: 12, 18, 26, 27, 28, 29 [researcher], 30, 53, 56, 72, 77, 78, 79, 81, 97 and 104.

Hypothesis **H4** states that in the VW there is a positive relationship between the users' chosen communication method and a reciprocation of the interaction. In this context, the method of communication that has been analysed on the basis of frequency of occurrence is group text-based interaction. The hypothesis asserts how

for any given participant there is a positive relationship between the number of text-based messages sent and received. The more text messages a participant sends, the more text messages he/she receives back.

The null hypothesis specifies that there is no significant relationship between the participants' amount of sent and received messages in PreVieW. This hypothesis is accepted if there is no established relationship between the number of text-based messages sent and the number of text-based messages received for each participant. The alternative hypothesis specifies that there is a significant relationship between the participants' amount of sent and received messages in PreVieW. This hypothesis is accepted if there is a relationship between the number of text-based messages sent and the number of text-based messages received for each participant.

H_0: There is no significant relationship between the participants' amount of sent and received messages in PreVieW.

H_1: There is a significant relationship between the participants' amount of sent and received messages in PreVieW.

To test this hypothesis, the BIC analysis was used to give a measure of the number of text messages that the participants send and receive, whilst the Pearson correlation method was used to determine the correlation between the number of sent and received text-based messages.

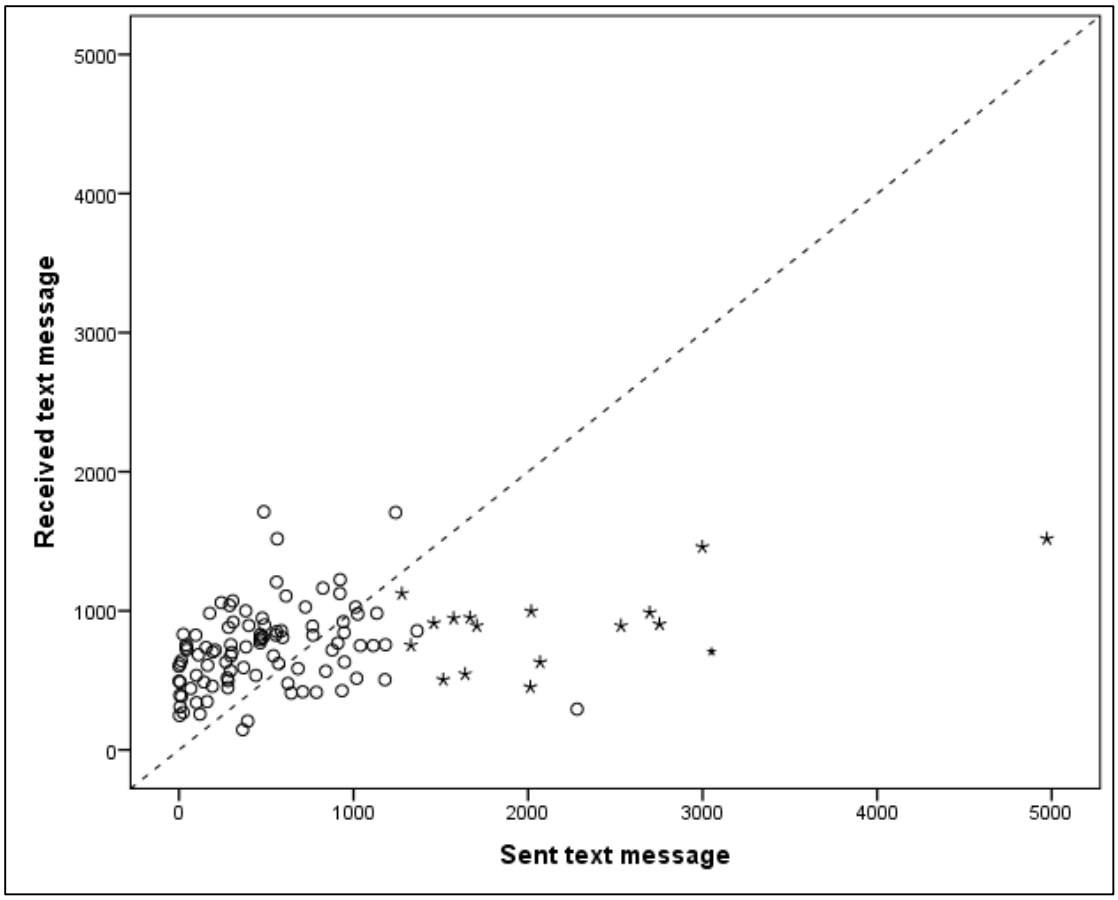

Figure 22 - Distribution of sent and received text messages for the whole group participants in Clusters 1 & 2 in PreVieW during October 2012

In Figure 22, all the respondents below the 45° line sent more messages than they received, while all the respondents above the 45° line received more messages than they sent. All the 17 respondents in Cluster 1 (marked in *) sent more messages than they received. Participant with ID.3 was the sole respondent who sent more than 2000 text messages altogether but was still grouped in Cluster 2. The reason is that participant with ID.3 was sending a large number of text messages to small group of participants (n<3) but was hardly interacting with the rest. It can be seen that in October 2012 there were more participants who received group text-based messages than they sent. The participants in Cluster 1 can all be found below the 45° line.

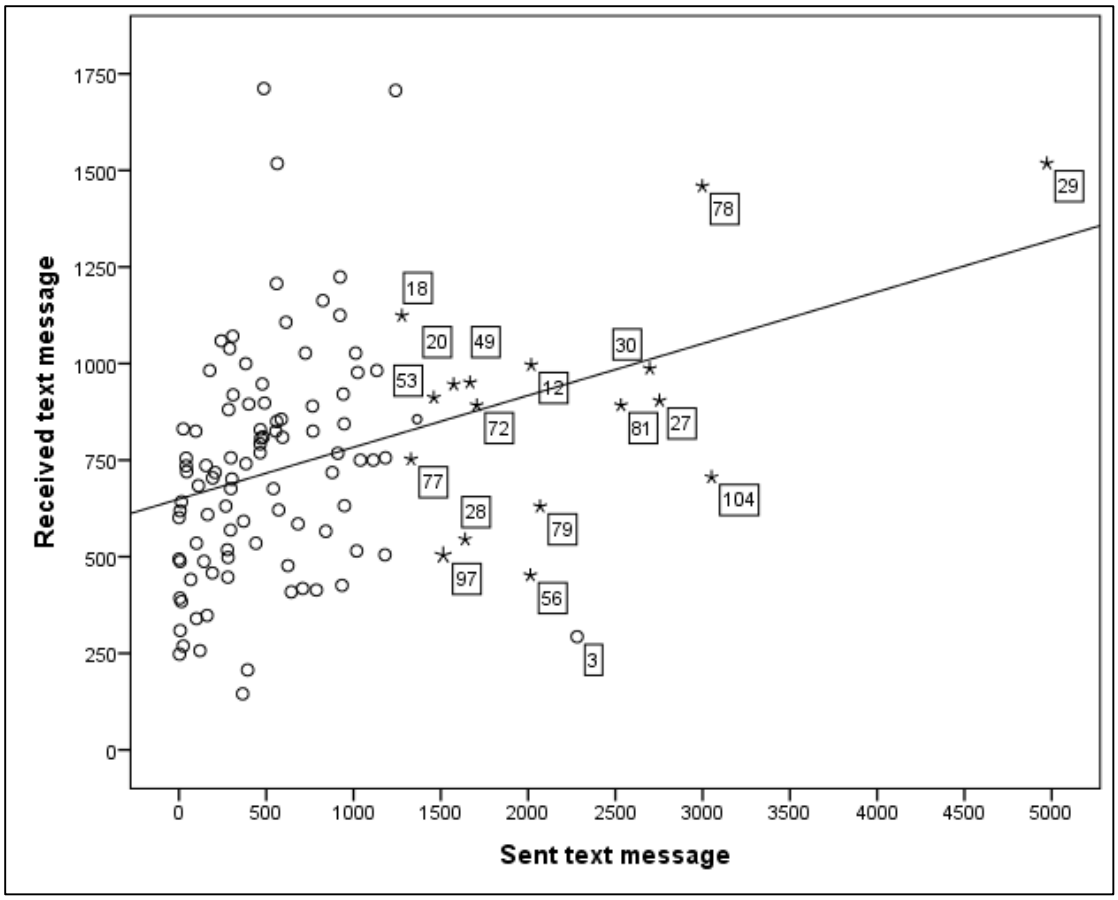

Figure 23 - Distribution of participants' sent/received group text messages during October 2012

The above scatter plot (Figure 23) displays a positive relationship between the amount of text messages sent and the amount of text messages received. Participants who sent most messages tended to receive more messages than others. In Table 17, the Pearson correlation coefficient (0.358) is significantly greater than 0 indicating that this positive relationship is significant and not attributed to chance.

From the results, there is a significant positive relationship between each participant's number of sent and received messages ($p<0.05$). This rejects the null hypothesis and accepts the alternative hypothesis, which states that there is a significant relationship between the participants' amount of sent and received messages in PreVieW.

Table 16 - Pearson Correlation for the relationship between the amounts of text messages sent and received

	Sample Size	Correlation	P-value
Text messages Sent and Received	111	0.358	<0.05

The research question in the theme, Social Connections, enquires whether increased interactions (due to their presence in the VW) would have an effect on the participants' change in the TAM results.

Hypothesis **H5** states that increased text-based interaction amongst avatars contributes to an increased change in the perception towards the adoption of technology practices in the classroom as evidenced by their pre- and post- experience survey responses.

This hypothesis predicts that the increase in the frequency of the participants' interactions inside the VW will have a significant effect on the participants' responses in the pre- and post- experience survey.

The null hypothesis specifies that the number of interactions in the VW has no significant effect on the participant pre- and post- experience survey responses. This hypothesis is accepted if no difference between the participants' pre- and post-experience survey is detected in comparison to their frequency of interactions.

The alternative hypothesis specifies that the number of interactions in the VW has a significant effect on the participant pre- and post- experience survey responses. This hypothesis is accepted if a difference is observed between the participants' pre- and post- experience survey in comparison to their frequency of interactions. In this hypothesis it is expected that more VW interactions would lead to more positive pre-post-experience survey responses.

H_0: The number of interactions in the VW has no significant effect on the participant pre- and post- experience survey responses.

H_1: The number of interactions in the VW has a significant effect on the participant pre- and post- experience survey responses.

A crosstab analysis between the results of the paired samples t-test and the member participants within the two clusters shown in Table 16 is used. The cross tab analysis

was performed on each individual item in the pre- and post- experience survey. The tables below describe the findings from this analysis.

Table 17 shows that there was a slight negative increase for the participants in Cluster 1 and a slight positive increase for the participants in Cluster 2. The terms negative and positive refer to the difference in the responses between the pre- and post-experience surveys. Thus, an increase in negative values would show that the participants' perceived usefulness of learning technologies decreased slightly after the experience. However, the values scored, as indicated by the paired samples t-test (Table 11), are so high that a slight decrease is not as significant. In Table 17, the participants in Cluster 2 (less interaction) scored a slight raise in their positive perceptions. However, there was no significant difference recorded for the two clusters in their variations of their answers based on their pre- post- scores as indicated by the p-value.

Table 17 – Change in perceived usefulness of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Perceived Usefulness of learning technologies.	Negative	Count	6	22	28
		Percentage	50.0%	35.5%	37.8%
	Same	Count	1	10	11
		Percentage	8.3%	16.1%	14.9%
	Positive	Count	5	30	35
		Percentage	41.7%	48.4%	47.3%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 1.067$, $p = 0.587$

Tables 18-20 all show an increase in the positive score between the pre- and post-survey results for both clusters. Even though the groups scored significantly higher for the three items under test, there was no significant difference between the clusters as indicated by the p-values of 0.658, 0.301 and 0.281 respectively.

Table 18 – Change in perceived ease of use of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Perceived Ease of Use of learning technologies	Negative	Count	4	22	26
		Percentage	33.3%	35.5%	35.1%
	Same	Count	3	9	12
		Percentage	25.0%	14.5%	16.2%
	Positive	Count	5	31	36
		Percentage	41.7%	50.0%	48.6%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 0.838$, $p = 0.658$

Table 19 – Change in attitude towards the use of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Attitude towards the use of learning technologies	Negative	Count	1	12	13
		Percentage	8.3%	19.4%	17.6%
	Same	Count	1	1	2
		Percentage	8.3%	1.6%	2.7%
	Positive	Count	10	49	59
		Percentage	83.3%	79.0%	79.7%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 2.399$, $p = 0.301$

Table 20 – Change in behavioural intention to use of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Behavioural intention to use learning technologies	Negative	Count	0	8	8
		Percentage	0.0%	12.9%	10.8%
	Same	Count	3	8	11
		Percentage	25.0%	12.9%	14.9%
	Positive	Count	9	46	55
		Percentage	75.0%	74.2%	74.3%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 2.539$, $p = 0.281$

Tables 21 and 22, show a considerable increase in a negative score to the items between the pre- and the post-experience surveys. This is due to the nature of the questions asked for the two items. The questions categorised under the heading for the item 'Perceived Complexity' measure the extent of complexity which the participants

attribute to the use of learning technologies. Their negative scores indicate that they believe that learning technologies are not so complex to get used to and work with. For the item in Table 22, the participants were asked if they feel they have to be forcefully asked to work with learning technologies. Their negative scores indicate their voluntariness in using learning technologies following their 3D experience. As for the previous tables and results there was no registered significant difference between the two clusters. This indicates that a significantly high number of text-based interactions held in PreVieW, did not affect their responses to their perceptions of learning technologies. The experience has had a positive effect on their overall attitude and acceptance of technology irrespective of the number of interactions which they had inside the VW.

Table 21 – Change in perceived complexity of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Perceived Complexity of learning technologies	Negative	Count	12	59	71
		Percentage	100.0%	95.2%	95.9%
	Same	Count	0	1	1
		Percentage	0.0%	1.6%	1.4%
	Positive	Count	0	2	2
		Percentage	0.0%	3.2%	2.7%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 0.605$, $p = 0.739$

Table 22 – Change in voluntariness for the use of LT between the pre- and post- experience for participants for different levels of interactions

			Cluster Membership		
			Cluster 1	Cluster 2	Total
Difference between the pre- and post- self-reported changes in Voluntariness for the use of learning technologies	Negative	Count	9	46	55
		Percentage	75.0%	74.2%	74.3%
	Same	Count	1	6	7
		Percentage	8.3%	9.7%	9.5%
	Positive	Count	2	10	12
		Percentage	16.7%	16.1%	16.2%
Total		Count	12	62	74
		Percentage	100.0%	100.0%	100.0%

$X^2(2) = 0.022$, $p = 0.989$

Tables 18-22 show the differences in responses between the pre- and post- experience surveys for the two clusters of participants. The values in the column for Cluster 1 are those values for the participants registering the greatest frequency of text-based group interactions, whilst the values in Cluster 2 are for participants registering less frequency in text-based interactions. The results indicate that there was a significant difference for all the items under measure for both Clusters irrespective of frequency of interaction ($p>0.05$).

The findings above thus accept the null hypothesis and reject the alternative hypothesis as there has been no significant difference in the participant responses between Clusters 1 and 2. This finding is quite significant to the field of SNA as applied to VWs in that it implies that an immersive experience can have a significant impact on perceptions, irrespective of the frequency of interaction between avatars.

Therefore in answer to the research question 'Do the VW activities encourage more VW connections and interactions inside the VW?' the analysis above shows that:

A. When there are planned activities in the VW the number of interactions between the participants increase.
B. The number of text-based interactions between the participants does not affect their self-reported changes in perception.
C. Social network graphs show that learner-centeredness was maintained throughout PreVieW especially during planned activities, as there was no one central node (teacher's node) that emerged during the participant interactions in the VW.

5.5 PARTICIPANT REFLECTIONS – RQ3

This RQ asks 'What are the pre-service teachers' reflections on learning in the VW setting?'

The participants[21]' reactions, motivations, thoughts and views are collected using focus group interviews with 4 groups of pre-service teachers (n=28) during and after PreVieW. Participants in PreVieW were recruited over email. Sampling ensured that participants came from all fields of study; humanities, sciences and languages. The participants were invited randomly on the basis of their group text-based interactions (Appendix 10).

The excerpts from the interviews show different perspectives by the participants about their perceived use of the VW experience. Interviewed participants expressed their opinions about how they enjoyed the flexibility PreVieW offered, in the way that they could connect from anywhere at any time. They expressed their preference for a modality which allowed them both freedom of expression, as well as freedom of interpretation of the content which was part of the VW. They were also free to express this freedom through their own teaching practice rather than learn about the content from a theoretical perspective. What increased its usefulness was that they could adapt what they constructed in the world to their teaching needs and requirements. According to the participants PreVieW allowed them to reinvent themselves in 3D and experiment in a safe environment whilst glimpsing at the world which many of their own students inhabit.

The difference between the measure of attitudes and perceptions lies in the approach to the data collection. Whereas the surveys give a quantitative measure to the changes in perceptions, qualitative data methods are used to inquire into how the perceptions of the VW as a learning medium change from the initial reactions to the final thoughts after the 13-week experience expires. The answers to this question are dependent on the learners' own perceptions of learning and how they translate learning from theory to practice. It is also heavily dependent on the self-efficacy attained by the learners, as

[21] In sections 9.3 and 9.4 the term participants is taken to indicate the group of pre-service teachers who participated in the small group interviews. The number of participants who voluntarily signed up to participate in these interviews is 28.

they set their own targets. The participants' perceptions and beliefs are analysed in the context of the qualitative data gathered using the insights from the interviewees as they reflect on their own learning.

All interviews were transcribed and translated from the Maltese language (native to the participants) to the English language for the purpose of the analysis of the data collected. In all the interviews counted up to 26,000 words and had more than six hours of transcripts. NVivo[22] was used to code the transcripts. Transcripts were imported in NVivo and categorised manually in a number of emergent themes. Colour codes were used in NVivo to identify the different themes. NVivo was used to determine the occurrence of the themes throughout the transcripts and a percentage of the occurrence throughout the text was given. Themes were classified on the basis of key words or related phrases. In all, 110 themes were identified, which were then finally classified under two broad themes using the methods outlined by Braun and Clark (2006). Themes emergent from the coding of a number of headings were based on the frequency of occurrence throughout the transcripts. xMind[23] was then used to map out the structure of the key themes.

The two main themes emergent from the focus group interviews leading to deeper insights into the participants' perceptions of PReVieW are: **VW Connections** and **VW Adjustments**.

Figure 24 shows a breakdown of all the themes emergent from the resultant transcripts. A bottom up approach was used to create the structure of the thematic map. This means that ontologies were developed to be able to categorise the themes under the relevant headings aiding the construction of the thematic structure.

A citation from one of the participants particularly captures the spirit of the discourse during the interviews:

> "We are all the time being told, that students are not as they used to be. Lessons need to be interactive as much as possible. And they should be fun. The good thing about the applied [PreVieW] and this is that it is literally

[22] nVivo is a software used in the qualitative analysis of unstructured data. Available online: http://www.qsrinternational.com Last Accessed: June 2014.
[23] xMind is a mind mapping software used for the structure of the key themes emergent from the transcripts. Available online: http://www.xmind.net/ Last Accessed: June 2014.

> student-centred. And if we want to teach in this way, it is a good thing to get used to this and we learn in this way ourselves. So for some courses [study-units] I agree that we need to change and we move towards this – gradually" (ID.3);

The themes related to 'VW Connections' dominate the transcripts and focus on the relationships developed as an outcome of and within the VW. Data from the interviews show how some of these relationships extended beyond the VW and were exploited during the teaching practice experience following PreVieW.

The theme 'VW Adjustments' refers to a more in-depth reflection of the factors related to the participants' perceptions of their real and virtual selves, the culture around teaching and learning in the VW as opposed to the physical one and their thoughts about direct practical applications on teaching. The sub-sections which follow analyse some of the insights from the participants. Detailed excerpts from the interviews can be found in Appendix 12.

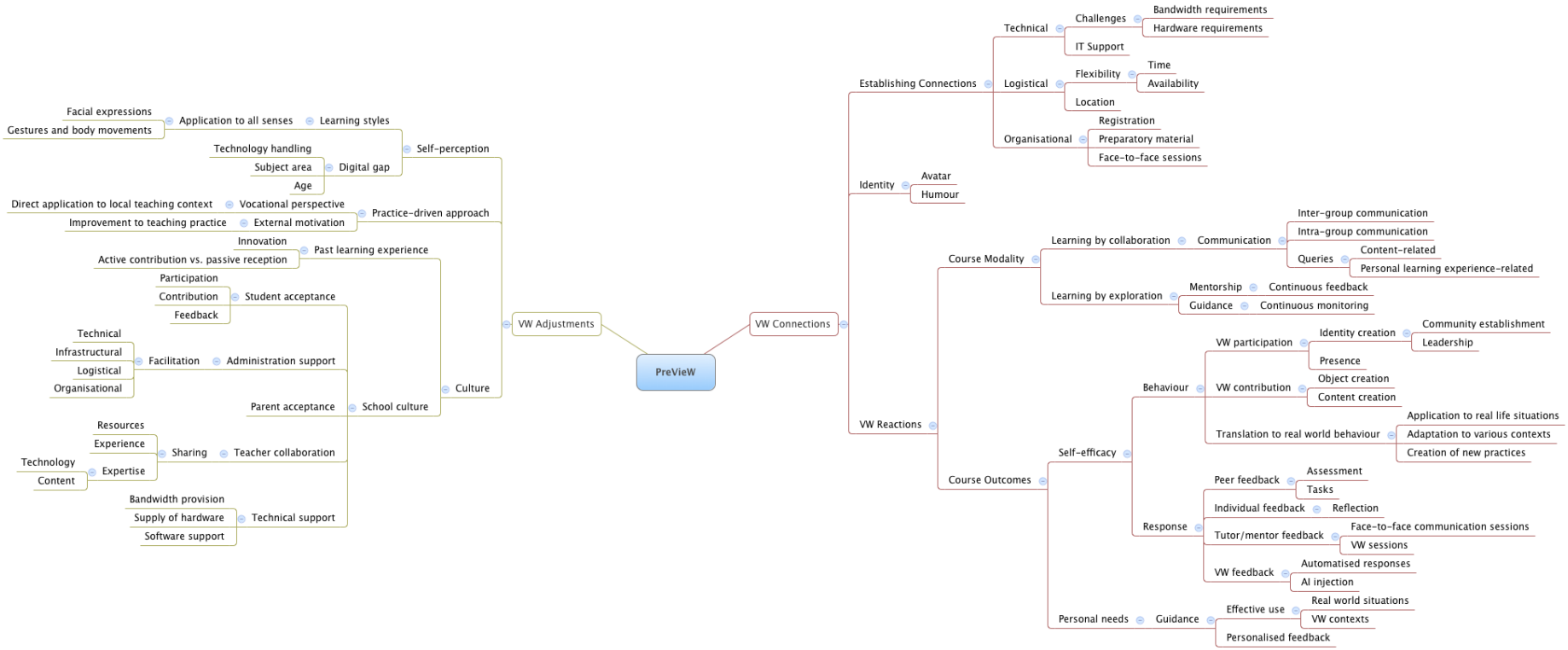

Figure 24 – Thematic map showing two main themes as emerging from small group interview transcripts about the PreVieW experience

Figure 25 shows the three sub-themes featuring in the **VW connections**. The main theme emerges from the way the participants in PreVieW established connections with the VW Platform, content making up the VW, and other avatars.

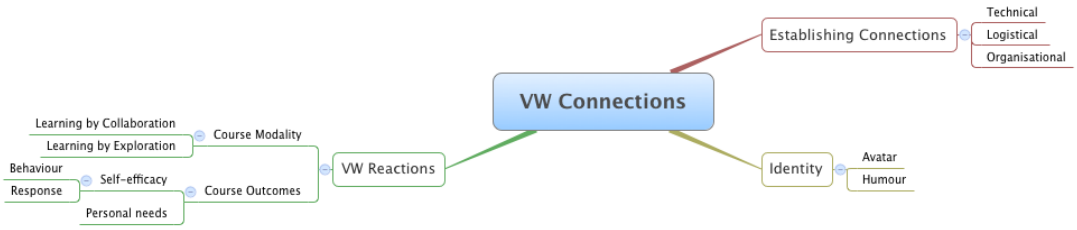

Figure 25 - VW Connection Key Themes

The three sub-themes are:

A. Establishing Connections

The connections with the platform were mostly at the technical, logistical and organisational levels. These included hardware and bandwidth needs, as well as the Internet browser requirements. For the most part, students who possessed netbooks with limited graphic cards, or who had a poor Internet connection from home were unable to participate fully within the VW. An online feedback form submitted after the first information seminar set inside the VW resulted in 40 of the 111 participants, reporting that they experienced loss of audio, and at times video, during the session. This loss resulted from poor bandwidth availability. Other challenges encountered included the lack of possession of headsets which would enable the participants to communicate using voice. This, together with the limited bandwidth, was one of the major reasons which prompted the participants towards text-based communication rather than voice-based communication. The common themes emerging in relation to the physical connection included IT Services [24] and Flexibility. Participants complained that it was difficult for them to connect to the VW platform because of the limited Internet connectivity whilst on Campus. This created a number of challenges for the participants, which they felt disrupted their learning progress inside the VW. The positive characteristic of the flexibility attributed to being able to

[24] IT Services in this context, refers to a department at the University of Malta, which offers IT related services and Wi-Fi connectivity across campus.

connect to the VW, any time from any place, was counteracted by the unavailability of Campus locations, when the participants necessitated connecting during the time when they were at University during the day.

The connection with other avatars was established through various communication channels, as visually displayed in the social network graphs created from the learning analytics collated from the VW platform. Text-based group communication, by far generated the greatest number of logs, indicating the most preferred form of communication chosen by the student participants.

However even this type of communication added to the challenge as participants reported that sometimes the messages were not coming across clearly.

> "Yes we found it more challenging – we were asking each other – there were people who understood one end, the others understood another end – so we were a bit lost in the world" (ID.41);

The formation of groups during the communication sessions can be identified. However, these groups are not clearly demarcated giving the indication that many people were communicating randomly, with the aim of getting to know people who were doing their same program of studies. Participants remarked that they got to know more people in the VW than they could do during the face-to-face teaching as most often they were split into groups depending on their subject area and field of studies.

There were instances when the participants felt that PreVieW's technical and organisational setup was more challenging, so they registered their preference for a more blended environment where they could meet with the lecturer face-to-face on some occasions.

B. Identity

Identity relates to the participants' perceived sense of self in the VW. It was interesting to note that whilst there were participants who could speak of their avatar in the third person there were those who referred to their avatar in the first person. Their sense of identity was also characterised by a degree of humour reported during the initial stages of adaptation to the VW experience. Only 1.7% of the overall

discussion during the interviews was related to avatars and identity. A particular conversation captures the participants' sense of identity in that is built within PreVieW:

> "I: No but if you had an image of the world – what would it be?
>
> I2: The skyline.
>
> I4: My avatar jumping [laughs] – my avatar that can sit
>
> I3: Running for the chair to get one [laughs]
>
> I1: He [avatar] would make a lot of silly things".

These citations show how the participants felt they connected to their VW identity. There were those participants who were totally immersed in the virtual space, whilst others retained, their observer status. This also explains the difference between those who interacted the most and those who interacted the least.

C. VW Reactions

The VW reactions theme related to how the participants not only accepted VW, but how it contributed to increase their perceptions about the usefulness of using learning technologies when teaching. This relates closely to the theme of 'self-efficacy' that featured quite strongly throughout the group interviews. The citation below, exposes what some of the participants discussed during the interview:

> "Rather than how to use technology I sort of became more open-minded to technology. Before I attended this course I used to say – but this Interactive Whiteboard, didn't we learn without it? Didn't we learn well? But now I am saying, with it, a lesson – for example, in science- before we used to draw the atoms on the board, now you can view the animation – so it is facilitating and helping visually especially those who are not verbally-oriented. So I am more open to technology after this course" (ID.78);

The interviewees could relate their learning experiences in PreVieW to what they produced in their written study-unit assignments (as part of their formal assessment), as well as to their six-week teaching practice following PreVieW. The participants' self-reported increased confidence in the use of Internet-based technologies followed

from the modality in which the study-unit was developed. The 'Course Modality' theme has been sub-divided into the two main pedagogical approaches built around theoretical frameworks and models. These include 'Learning by Collaboration' and 'Learning by Exploration'

a) Course Modality

The connection at the content level included the course modality designed around the learning by exploration model. In this type of model participants were expected to build their own learning experiences, and to discover niches in their learning according to their individual needs. The challenges at this level were identified in terms of the lack of experience with such a model throughout their formation years. Participants frequently mentioned the consumption of the content available directly from the VW platform. However, few ($n<3$) student participants displayed enough confidence that would prompt them to contribute to the VW content, without being explicitly told to do so.

The following excerpts give a deeper understanding into how the participants perceived the different modalities inside PreVieW:

> "For example, when you used to tell us we'd be having a presentation on a certain topic. You would let us choose to do whatever we wanted for it. There were those who would feel lost in it. There is the added fact that there wasn't a set curriculum. There were themes" (ID.18);

One particular issue, which is also discussed more in-depth in Chapter 6, is the interviewees' mention of the need for more step-by-step guidance in the adaptation to the new modality for learning. The ELM and Connectivist model approach required the participants in the VW to explore, experience and connect and for many this was a totally unique experience in a setting they had always heard about.

b) Course Outcomes

The course outcomes were determined by the participants' reported level of self-efficacy and self-belief following PreVieW. Participants reported an initial sense of fear of the unknown as they were immersed in an experience which was new to them. However, the interviewees also indicated that throughout the 13-week period they

managed to achieve more confidence in their abilities, and to acquire an increased know-how about technology that is applied to practice.

> "At first, you know as I told you – I was a bit wary but then after the orientation, I thought "Ah ok – so you can do this, this and this and that is perfect." So then it was great. If all the lectures had to be like that – ok, not all lectures can be done this way but it is so time efficient – it is so much more 'comfortable' for those who teach and for those who are learning – you can access all the information whenever he wants, wherever he wants at whatever time he wants" (ID.17);

The **VW Adjustments theme** (Figure 26) emerged from a number of insights made by the participants about their overall perceptions of PreVieW in relation to their teaching and learning experience.

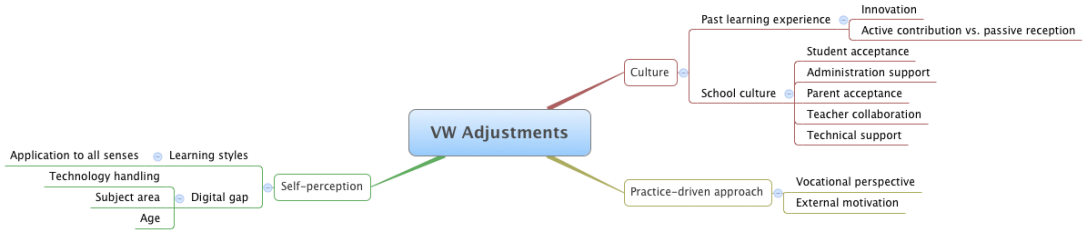

Figure 26 - VW Adjustments Key Themes

The three common sub-themes making up the VW Adjustments are:

A. Culture

A common theme was the mention of 'Culture' with reference to different contexts. In one context, the participants view culture as an effect of their past learning experiences, whilst in another context the participants mention culture in relation to their perception of teaching in the school setting. Their perception that the schools are not yet ready for this form of teaching and learning have an effect on their overall perceived use of the technologies in the classroom.

From the participants' comments (see below), it can be surmised that a number of the participants mentioned that learning technologies and the way they are applied is not consistent with their past and current learning experiences that are of a more traditional teacher-centric approach.

"However, overall the experience was really different. I didn't feel it belonged to University. It's like with everything. If I were to make a chocolate cake there will be those who will like it and those who will not, there are people who have been used to traditional note taking. I think they found it strange or maybe they would ask: Is this really a lecture? Am I taking enough information?" (ID.43);

B. Practice Driven Approach

The participants' perceptions about how they could apply learning technologies to their classroom practices was another identified theme that emerged from the interviews. Some of their comments indicate that the participants are aware of the different school situations as they professed a degree of perplexity about the expectations from schools and different stakeholders.

C. Self-Perceptions

During the interviews the participants show that there was a period, especially at the start, when they were unsure of what was expected of them. This indicates lack of confidence in mapping new learning directions. However, their self-reported changes in perceptions indicate that they adapted and that they were aware that they were learning in a different way to that which they had been exposed to previously. In the excerpts which follow, the participants show that they not only broadened their views, but they have also internalised the concepts that have lined the VW experience in a way that they felt comfortable enough experimenting with in their own classrooms as teachers.

"It's been ages since I stopped from school and studying and I just started back now, this year. When I started out – this 'learning…" all virtual and all that … I just couldn't get to grips with it. And then, …"(ID.3);

"I thought I was a bit knowledgeable about computers and stuff and now I realise that I am not so knowledgeable at all" (ID.98);

"I never had – I know how to use the computer but I never had to work using the computer" (ID.111);

The comments above show the participants' lack of self-belief when they started out the PreVieW experience. The comment below captures the overall perceptions demonstrated by a number of participants during the interviews:

> "I think that was what we lacked. We have always been used to being told how to do stuff and to follow certain steps…to present this and so when something was different – the VW gave us the space to be more free but when we felt this space – we're so used to being closed in – I think that this is also something negative about schools – we're so used to being given notes and stuff rather than having them, as students, working – I think the mentality is changing but maybe we're the ones who are used too much to that kind of mentality."(ID.79);

The excerpts above indicate that the participants had also started out on their learning journey with a preconceived notion of what learning technologies were all about. Many were limited to what they had previously experienced at school and at higher education. However the comments show that PreVieW changed those notions not only through the learning design, but also through a setting that was immersive and which provided the right environment to stimulate collaboration, communication, creation and connections. In answer to the sub-question 'What are the pre-service teachers' reflections on learning in the VW setting?' the analysis shows that:

A. The quantitative data reporting a positive shift in attitude towards learning technology is further supported by the qualitative data collected from the focus group interviews.
B. The reflections from the participants, give an indication of what they have valued most and least in PreVieW. The participants valued most the virtual setting, the possibility of experimentation, and the innovation within a formal education program, whilst the technical challenges (including bandwidth limitations) were valued least.
C. Immersion, avatar identity, and the 3D space helped them view the culture of learning from a different perspective.
D. Comments indicate that PreVieW has helped the participants shift their mind set from a more passive one to a more open and active one.

5.6 Real World Behaviour – RQ4

RQ 4 asks 'How do the pre-service teacher participants demonstrate the transfer of learning from the VW to real world practice?'

In this thesis, the students had the opportunity to experience a teaching experience of a six-week duration, following their immersive experience in the VW. Focus group sessions were held after this teaching experience. As part of their discussions, the participants were encouraged to reflect on what resources, tools, methods and technologies they made use of during their practice and whether they thought that the VW experience contributed to new ways of enriching their practice.

During the focus group interviews, the participants describe how they are able to connect the use of learning technologies to their teaching practices in the classroom following PreVieW.

In the interviews, the participants give examples of what they did during their pre-service teaching experience. Their self-reported actions were not a requirement of the study-unit which framed the VW experience. Their actions were part of their own initiatives during their teaching experience. Their reporting gave an indication of the diverse ways in which they applied the learning. The importance of these comments lies not in the failure to mention the use of the VW, but more in how the participants managed to assimilate the pedagogical frameworks applied in the design of the VW and repurpose them for their own teaching.

> "The lesson I remember is what I have already described, the transport lesson. At first I had the problem with the Interactive Whiteboard but then somehow I did something with the cable and I connected. So the lesson wasn't planned like this; there was a lot of myself talking planned for that lesson. However, since it took a lot of time to set up the interactive whiteboard I decided to go for the French games immediately. I told them that we would be doing a transport lesson. I split them in two groups and the game itself first teaches you some words. I told them to pay attention as then they would play games. Their first reaction was 'Games?' There was a lot of excited shouting in class" (ID.17);

> "I think it was during the last week and it was about Italian culture and modern art. It was an introduction. I found pictures of the 3D street art so I asked them 'is this art or not'? Then I found stuff which is not conventional to which they would answer 'ah yes'. You could see and you could feel that they enjoyed it" (ID.83);

The quotes above show that the socio-collaborative and exploratory model applied to the VW experience, enabled the participants to assimilate learning in a personalised way that suited the teaching of the different subject areas. The participants' discourse also tends towards a display of self-development as they give indications of what they learn and how they apply it in their journey of their self-discovery.

The interviews have shown that the participants reflected about their VW experience and how this had an effect on their teaching. Although it does not give a clear indication of how the participants will be making use of the experience for their future teaching, some of their responses show the level of satisfaction from using alternative practices for their classroom teaching. The period of reflection following PreVieW coupled with the teaching practice that gave the participants the possibility to put into practice what the VW experience transmitted, was an important factor in gaining more insights about the role of VWs on real life behaviour.

Throughout PreVieW, the researcher used a personal log, detailing views and reflections about the experience. This was done because the dual role of the researcher (having developed and been present throughout PreVieW) could be an influential factor in the experience. By keeping a structured personal log of reflections about PreVieW, the researcher has the possibility of using the insights and reflections to understand some of the interviewees' responses. Reflections were recorded weekly throughout the PreVieW experience using a SWOT technique to describe the strengths, weaknesses, opportunities and threats influencing the experience. The personal reflections have been analysed using the same process and approach as for the other unstructured qualitative data. The main theme emergent from the analysis of the reflections is the 'Real World Behaviour'.

Some important details emergent from the interviews indicate a discrepancy between the findings from the participants and the researcher's reflections. The discrepancy is mostly in the perception of the use of the VW experience to the real world behaviour. Whilst the findings gathered from the quantitative, unobtrusive and qualitative

methods indicate that PreVieW has had an overall positive influence on the pre-service teachers' perception of technology practices and their real world behaviour, the researcher's reflections indicate that PreVieW was not exploited as designed initially. PreVieW's design is targeted to encourage exploration, social collaboration and the setting up of communities of practice without the need for explicit instructions. However, the findings from the quantitative, data collected indicate that planned learning activities increased participant interactions, whereas interactions decreased considerably when no interactions were planned.

In answer to the sub-question 'How do the pre-service teacher participants demonstrate the transfer of learning from the VW to real world practice?' the analysis shows that:

A. There was a considerable uptake of digital practices that were either experimented with or discussed by the participants during PreVieW in their class teaching practice.
B. Participants were not fully aware of their increase in self-belief in learning technologies until they started their teaching practice.
C. Participants valued PreVieW more following their own teaching practice which highlighted their strengths and gave them opportunities to work with methods which they had assimilated during the VW experience.

5.7 Chapter Summary

The main research question asks how the 3D VW would affect the pre-service teachers' perceptions of learning technologies. Quantitative data from the findings have revealed that PreVieW has had an overall positive effect on the participants' perceptions of classroom technologies. It has also shown that factors such as age, gender or field of studies, have not had a significant effect on the changes in the participants' perceptions. Moreover the findings have indicated that whilst PEOU, behavioural intention, attitude and experience may be variables that have affected the participants' perceptions following PreVieW, increased social interactions in the form of text messages that are sent and received by the participants have no significant effect on the changes in perceptions about classroom technology acceptance and adoption. Data logs from the VW indicated that whilst planned activities increased the

text-based interactions between the participants, such interaction did not affect the participants' positive shift in attitudes and perceptions of classroom learning technologies. Qualitative data, on the other hand shows that the participants valued the flexibility of the VW platform, the activities, and the actual 3D setting that offered a space for experimentation and exploration. The challenges with PreVieW lay mostly in the technology and with the fact that the local school scenario and infrastructure does not support VWs. The reflections have also given an indication of the acceptance of the VW environment by the participants as they internalise their avatar identity, through the relationships originating within the VW and sustained beyond in the physical world. Qualitative data have also indicated that the participants' confidence in their digital practice abilities has increased as a result of the VW experience. The chapter which follows discusses these findings in relation to their contribution to the body of knowledge surrounding the application of VWs to teacher education.

CHAPTER 6

DISCUSSION

6.0 INTRODUCTION

This chapter discusses the findings presented in Chapter 5 in terms of the key factors that influence a change in technology perception following, influences on learning, the role of social connections, as well as the researcher roles and influences on the participants in PreVieW. Following a discussion of these themes with reference to the findings, two main contributions to the body of literature surrounding pre-service teacher education and VWs emerge. The first contribution that is discussed is the connective learning model for social VWs. This model explores the dynamics involved in a socio-collaborative design for VWs in education. The second contribution is a framework for the integration of VWs into teacher education programs, to help overcome the challenge of accepting and adopting classroom learning technologies. Emerging from this framework are 10 propositions for the integration of VWs in pre-service teacher education.

6.1 PREVIEW: KEY FACTORS, INFLUENCES AND ROLES

PreVieW is characterised by a series of factors, influences (external and internal) and roles that have had an effect on the experience. Although PreVieW itself was held in the VW, the participants brought with them their experiences of teaching and learning which were ingrained in their real life experiences. Moreover, influences from their pre-service education program, part of which was also their pre-service teacher classroom practice experience, has given them additional perspectives on their perceptions and applications of technology for teaching and learning. The role of communities mediated by communication and social-collaborative practices has also been important in PreVieW.

In PreVieW, the key factors identified as having an influence on the pre-service teachers' perceptions of technology are PEOU, behavioural intention to use the technology, attitude and experience in the use of technologies. Teo (2009) as

discussed in Chapter 3, posited that it is common for variables to interact with each other, and have a direct or indirect effect one another. In his studies, Teo concluded that whereas PU, attitude and computer self-efficacy have a direct effect on behavioural intention to adopt technology, PEOU, technological complexity and facilitating conditions have an indirect effect on the behavioural intention to use technology. In this thesis the participants who took the pre-test reported a conception of their abilities as rather low. In fact, their self-reported perceived complexity of technology applications and their reported voluntariness showed that they initially believed that technology applications tended towards being more complex and they were less likely to voluntarily use technology applications in their teaching. The change following their VW experience was quite marked and significantly different for these two perceptions.

Qualitative data collected from the participants during the focus group interviews have shown that their initial lack of confidence was a result of their perceived abilities in handling technology. Some have attributed this lack of perceived abilities to age, field of studies or experience. Whilst some interviewees mentioned that they had left academic studies for a period of time and that the way they used to learn was different to the way they were expected to teach nowadays, others mentioned that their academic background did not make it easier for them to be naturalised into the technological environment. However, despite these personal claims, findings from the quantitative analysis of the pre- and post- experience surveys showed that age, gender and field of studies had no significant effect on the responses submitted by the participants, meaning that whatever the age, gender or academic background, there was no significant difference between the group responses.

What can be seen from these findings is that whilst PreVieW seemed to have a direct effect on the participants' self-efficacy towards classroom technologies, the experience itself had an indirect effect on the acceptance and adoption of learning technologies in class. During the interviews, the participants in this thesis revealed that the course outcomes are inter-related to self-efficacy and personal needs. The self-efficacy is manifested in their behaviour and the response they got from the VW (in terms of the feedback from their peers, their tutor, the VW objects and their self-reflections). According to the interviewees, most of the adjustments that are needed to improve PreVieW relate to their self-perception about the way they should handle

technology applications in the classroom. Their responses clearly show a lack of confidence in their abilities, which by their own admission, improved significantly after the VW experience, and much more so, after they had concluded their teaching practice where they had the possibility to try out in practice what they had experimented with during their immersive experience.

6.1.1 Social Influences on Learning in VWs

Social learning theories view learning as not only a complex activity, but as hinging on social ties constructed within the context of learning. The construction and deconstruction of knowledge does not happen as a result of isolated experiences, or experiences which occur in isolation. As discussed previously in Chapter 3, Hossain & de Silva (2009) investigated the role of social ties in a virtual community and they established that such ties could have a major influence on users' acceptance of technology. In this thesis, the participants registered their presence by logging into the VW and setting up a profile. The participants' movements inside the VW, together with their textual and vocal interactions were logged by the VW platform. This gave an indication of the social presence, in terms of the peer interactions. Although the interactions themselves do not give an indication of knowledge construction, their representation gives a clearer insight into the way the communities inside the VW were formed as well as the interactions between the participants. The interactions represented by social network visualisation in the form of a graph produced information about the extent of the peer interactions. Through these logs it was concluded that owing to a number of reasons, including technical limitations, the most popular mode of communication by the participants were group chats (text-based group interactions) as opposed to private text chats or voice conversations.

Data from the interviews reveal that participants got to know each other more from the VW than from their traditional face-to-face lectures on campus. The reason they attributed to this was that being a group of more than 100 students did not help foster socialisation when they were in a traditional classroom, whereas the VW supported the possibility of discussion in a more informal and less traditional setting. The interviewees describe how in the traditional face-to-face setting they get to the lecture rooms, find a place, sit, take notes and then leave without the opportunity to socialise, discuss or speak to other people. One interviewee mentioned that for some study-units

in the program, the students were purposely split into groups pertaining to their field of studies, thus removing the opportunities for them to share experiences with their peers coming from different academic backgrounds. The VW setting, its user interface and the design of the tasks gave the participants the opportunities for serendipitous encounters with different people from different subject areas. The connections between users reflected the style of learning in the digital era, as described in Chapter 3 of this thesis, namely as learner-centric, learner-driven, connected, social and communal, and informed by the learner's online behaviour. This online behaviour can also be identified from the social network graphs showing that whereas in the first month of the VW experience, the interactions were more widespread amongst all the participants with the exception of two participants, in the second month the interaction patterns changed. In the second month of the VW experience, the number of participants who participated less in the group text-based discussions increased. However, the graphs also indicate stronger and tighter connections between the nodes. This means that although fewer participants interacted in groups, the interactions in the VWs were more frequent and more consistent. Smaller communities were also more apparent during the interactions happening in this second month.

During the first month of the VW experience, the participants were asked to explore the various objects inside the world, and reflect upon them. Small tasks were given with the objective of getting people to discuss amongst each other, whilst initiating a collaborative work experience. During this month, many of the conversations in which the researcher was involved were more social related rather than content based, where the participants were more intent on getting to know more about each other, the different interests and sharing their experiences about the teacher education course. This experience served for the participants to meet each other in an informal online setting.

The second month of the PreVieW was highlighted by two major events. The first event occurred outside the VW. The participants were enrolled in a three-week teaching practice at local schools. During this period the participants did not visit the VW, despite the persistent nature of the environment. This was evidenced by the VW data logs. During the interviews, the pre-service teachers explained this as a phenomenon occurring during their teaching practice. The interviewees mentioned

that when they had asked their peers, the response was in general that as pre-service teachers they were so apprehensive in preparing their lessons and resources according to their tutor's set indications and guidelines, that they felt they had no time to "play" or explore any other environment. By their own admission, the interviewees "didn't even have the time to log on to Facebook during their teaching practice". This is an interesting concept which definitely warrants more discussion amongst those responsible for pre-service teacher education. Teaching in itself is an inherently social activity. The design of the VW was such that it permitted social collaboration and communication in a way that can aid and enhance teaching as a social activity. Yet, during the pre-service teaching practice, the participants felt that they had no time for it because they were too focused on writing lesson plans and preparing resources. What is interesting to note is that many of the interviewees reported that they used resources, practices and tools which they either experimented with or experienced directly or indirectly in PreVieW during their second teaching practice. This teaching practice followed some four weeks after PreVieW had ended.

The second event was the assignment of specific tasks, which the participants had to complete by working collaboratively in groups. This is also evidenced by the VW data logs and the interactions were demonstrated as a pattern emergent from the social network graphs. The tasks designed for group and collaborative work fostered the formation of small communities inside the VW, creating a pattern with a more cohesive network characterised by smaller groups and more frequent interactions.

Although there was no direct assessment of the cognitive skills acquired inside the world, it is believed that the influence of the key factors in play inside the VW made it possible for the participants to reach a deeper engagement with the subject, enabling them to pursue the topics further – this in itself leading to a self-reported "learning" of the topic concerned. During the interviews many of the participants expressed their satisfaction at feeling that they have learned what they wanted to, without any prescribed content, even though the content was freely available. Many of the participants reported that the experience served as an "eye opener" and to raise awareness about what was possible. One participant referred to PreVieW as being built by all the peers. As this participant observed, "so I think the unit, it wasn't just us receiving something, but we actually did the unit".

They related the learning inside the VW as part of the course outcomes, or rather what they took back from the experience itself. During their interviews some tried to compare it with the MOODLE VLE, which is used as the primary learning environment at the University of Malta. One of the key factors which they described as differing from the MOODLE experience, and which can have influenced the degree of self-reported learning from the VW is the way of expression, not just through text or voice, but also through their movements across the space. Many of the participants commented about their avatars, which some referred to as their "doll", and how at times they lost control of it, whilst at other times they identified themselves with it. Other factors that had an influence on the participants' learning experience inside the VW included the multimodality, which they could associate with and could also interpret in terms of their everyday experiences. Videos were mentioned as part of this aspect. Although technically, videos can be uploaded directly on the MOODLE VLE, the experience of sitting down inside the VW and watching them simulates the experience of being in an entirely different location to playing the same video from the VLE. This sense of 'being there' was discussed extensively in Chapter 3 through a description of the immersive features of a VW and how this may influence user behaviour.

However, from the perspective of their perceptions of learning, it was interesting to note that some of the comments lead to believe that they did not believe learning was taken at a serious level through this experience. Many of the participants mention the lack of note taking as primarily affecting their and their peers' perception of learning. Many of the participants refer to the term 'culture' as that which has been ingrained following years of schooling. According to their perception, learning happens when a teacher or a lecturer stands in front of the class or audience and teaches or lectures. This is completely divergent from the view of student-centred learning, as professed by many educational theories. In Chapter 2 of this thesis, it was argued that one of the main challenges for technology acceptance and adoption in the classroom is the gap between the traditional way of recognising knowledge and the 21st century way of creating new knowledge using technology. As discussed in both Chapters 2 and 3, in an era characterised by connections established through the online medium, an individual can be able to construct learning, in targeted online communities, but also as part of the medium itself through the co-production of knowledge objects and

artefacts. The quantitative findings in this chapter show that the human-computer interaction is facilitated through the networks established within the 3D VW. The qualitative findings then show that the participants have extended these networks and connections to form small communities of practice inside and outside the VW to reach their teaching targets.

6.1.2 The Role of Social Connections in the VW

The social network graphs and analysis show that the social setting in the VW facilitated the connections between the avatars. This occurred seamlessly at first as the participants manifested their eagerness to explore the world and communicate with the other avatars. A number of participants chose to connect to the VW from the comfort of their own homes, in the late evening or early night-time. During the interviews, participants mentioned that this would be the time that was most convenient for them to study, so they would at times snatch the opportunity and connect for maybe 15 to 20 minutes at a stretch. It was also interesting to note that many of the participants at the start logged on because of their curiosity for the study-unit. However, some of the participants also admitted that through logging in they got to know participants who they did not know from the face-to-face classes on campus.

Although many of the theories presuppose that connections lead to knowledge acquisition, the responses from the qualitative data collected, indicate that rather than content-based knowledge, their level of motivation to get to know more about the subject increased. By having the opportunity to discuss together, reflect on the experiences and share their ideas about the subject, many of the participants admitted that they felt more self-assured to keep exploring the subject inside the world, as well as outside the VW itself. The role of the social connections in this thesis is to help the participants reach a deeper level of engagement with the VW and its contents by creating opportunities for the participants to engage in conversations to complete the assigned tasks. The participants reported that rather than learning, the experience helped to make their own cognition clearer through the possibilities for discussions and presentations, which they had to deliver as avatars inside the world. In addition, the participants also reported that the experience helped them explore learning themes without any restrictions or limitations imposed by rigid curricular structures. According to the participants, their connections and interactions inside the VW helped

them engage more deeply with the chosen theme to express their ideas in this written assignment.

The role of social connections in PreVieW also comes out in the quantitative analysis of how the number of text-based interactions affects the participants' responses on their perception of technology in the pre- post-experience survey. If the communities set up and their role on self-efficacy had to be reduced to the amounts of text-based messages which the participants send and receive, the results from this analysis show that there is no significant difference in the responses towards technology perception. This indicates that whether the participants sent and received 20 or 2000 messages had no effect on the positive or negative responses in the pre- post- experience survey. Participants tended to show an overall positive response to PreVieW irrespective of how many text messages they sent. It has to be added that this thesis has not investigated and analysed the discourse within the text messages and thus, many such messages may have been totally unrelated to the study-unit. Interviewees reported that the experience of "just being there" and seeing each other as avatars, listening to the talks, watching each other's work, was enough to help them change their perception about technology and its role in learning. This would sustain the claim that connections in VWs are not just about establishing contact with avatars, but about building a relationship with all that the environment has to offer in terms of content, space, embodiment, and communication.

6.1.3 Researcher Roles and Influences

As discussed in Chapter 4, the researcher had a multiple roles in PreVieW covering both the design and development as well as the collection and analysis of data. However the researcher was also leading and coordinating the study-unit that provided the structure for the integration of PreVieW in a teacher education curriculum. Therefore there was a high risk of influence on the participants and ensuing findings due to the subjectivity arising from the researcher's various roles. To minimise this subjectivity, the researcher took a number of precautions and set in place a number of indicators that would raise the level of objectivity for the collection and analysis of the findings.

In the first instance, the researcher's PreVieW design included activities that were mostly learner-centric and learner-led. Therefore whilst the content that was set up initially in PreVieW related to a number of pre-defined topics, the participants were encouraged to research and upload content related to the topics in order to populate the VW further. In the second instance, participants were given the freedom to form their own groups, and work with other participants of their own choice. Participants who did not belong to any group were randomly assigned to other groups. During the experience, no formal lectures were held. Topics of discussion and learning objects were randomly generated and assigned to the various groups. Learner-led public information seminars were planned designed in a way that the participants themselves could present their randomly assigned topic with minimal interference from the researcher. In this way, bias and influence from the researcher arising from talks and lectures could be kept to a minimum whilst encouraging participants to be more active in their learning process. The immersive nature of the VW was exploited during VW activities and driven by participant actions. An identified threat was the study-unit assessment. In order to minimise the researcher bias toward the participants, they were assessed individually on the production of a research paper. Assessment criteria were given to the participants in advance and assessment was carried out on the basis of a rubric which was also shared with the participant learners prior to the submission of their paper. In this way it was believed that the participants could feel free from the impending threat of answering in the way which they believed might influence the grading of their paper. In addition the participants could be free to select any topic of their choice on the basis of their VW connections and encounters. In this way, although the initial design and development of VW as well as the design of the learning activities were driven by the researcher, the experience itself was something which was constructed by the participants themselves and not influenced by the researcher's personal beliefs. The collection of the data itself was also identified as a possible threat in skewing participants' beliefs. This was therefore planned and structured in a way as to minimise the researcher's influence. A validated TAM instrument was used to collect participants' self-reported changes in perceptions before and after the experience. The data logs in the VW were collected from all the participants and were generated automatically by the VW every time each participant logged in. The qualitative interviews were conducted after the study unit assessment was already published. This was done so that the participants would not feel pressured

into answering in a way that they might feel would advance their grades. These measures were taken in an attempt to limit the researcher influence on the participants' responses that might in turn skew the findings and their analysis.

6.2 VWs, Technology Acceptance and Pre-Service Teacher Education

The two sub-sections that follow, discuss the contribution of this thesis to the body of research surrounding VWs, technology acceptance and pre-service teacher education. The first sub-section considers the connective learning model as a proposal for the group behavioural dynamics in a VW pre-service teacher education context. This emerges from the data collected and analysed as a result of PreVieW. The second contribution is in the form of a framework for changing attitudes to learning technologies using VWs as a medium. Emerging from this framework are 10 propositions for the integration of VWs in pre-service teacher education.

6.2.1 The Connective Learning Model for VWs

The role of VWs in education has been discussed extensively in Chapter 3. Although the studies presented don't all consider the use of VWs in a formal education setting, there are some points of convergence for all the studies. These points of convergence are interactivity, access, and connectivity. However, despite the fact that VWs can be designed to foster social interaction and collaboration in an immersive space, they can also sustain different media and modalities to include activities associated with fun and enjoyment. Participants being interviewed have indeed remarked that their perception of learning in the VW was that of better clarifying that which they had known about. Rather than transferring content and information, the VW was exploited to help the learners make the connections between what they inherently acquired from previous experiences, their peers' experiences, and new ideas which were presented in the different forms of media held within the VW.

The connective model for VWs (Figure 27) illustrates how PreVieW influenced the formation of beliefs through the connections established with the avatars, and 3D objects present in the VW. As the avatars are created, identities are developed, roles established and trust is built. The provision of content that is presented over multiple

modalities helps establish the sources from which the learner starts creating meaning. Reflective spaces are then needed to be able to self-organise the knowledge presented in the VW with prior knowledge. The knowledge that is built up within the communities arises from the distribution occurring across the network and as a result of multiple modalities. The tacit knowledge within the community is dispersed within the network, thus establishing clear position of beliefs. The network becomes the medium of transmission for the knowledge. The dynamics of the group beliefs formed over the network connections affect the individual's self-belief to different degrees and extents.

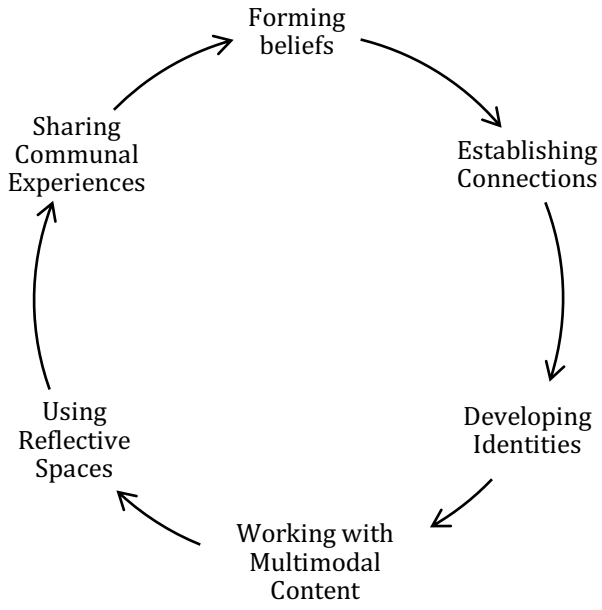

Figure 27 - Dynamics of belief formation in VW communities; the connective model for VWs

In this thesis the participants used the VW space to share the outcomes from their assigned tasks with the rest of the group, during a number of information sessions. However, they also took agency over their own learning, as the participants refer to the VW as their space during the interviews – a space, which they have populated with content of their own. The VW itself provided a safe haven for the participants who have professed their initial reluctance to apply this technology, to use the space to be able to experiment and work in groups in a risk-free environment. During the interview, it also emerged that the participants felt more confident in using different technology-based media in the class following their practice with the media in and for

the VW experience. This also corresponds to what Gee (2003) refers to the 'Psychosocial Moratorium'. This moratorium is the space where the person who is part of the virtual experience, whether this is a game or a VW environment, feels free to take risks in the decisions that affect the outcome of the game or the virtual experience. This risk-taking most often leads to experimentation and exploration with the justification by many that this is a safe environment, with decisions that will not have a direct and immediate effect on real life practices. Such actions would very often be ignored in real life contexts because of the resulting consequences that these could have.

For pre-service teachers, such experimentation and exploration of technology practices are often not favoured in the physical class environment, because of the possible risks and threats this might place on class control and management. By the teachers' own concessions, and as evidenced by the participants' responses, their perception of the new generation of learners, is that they are more technologically savvy than them. They often and still make use of Prensky's (2001) reference to digital natives versus digital immigrants, work that dates back to 2001, and which is now subject to much criticism when applied to this digital era. This leads them towards the belief that they, as adults, can never equal what their young learners possess in terms of hands-on experience with the use of technology. Together with the often limited amount of resources and possible support that various schools have faced in the past, this lack of self-belief has reinforced the notion that experimenting with technology in class can be dangerous and can lead to undermining the role of the teacher.

Many of the participants in this thesis refer to this role as being part of the teaching "culture" which they have grown up with, and that sees the teacher as the central actor in the classroom setting. The social network analysis of the text-based interactions occurring inside the VW shows that in the first week of text-based interactions, the researcher takes on a more central role in the network. Various smaller group interactions can also be identified lying at the periphery of the core network.

Following the first week, the topology changes as tasks are assigned. From the network analysis it could be observed that the initial centrality of the researcher is overcome as the participants in the world immediately take agency and start

interacting amongst themselves, identifying those who would speak to the rest of the participants and those participants who would help out by displaying content and other material.

This thesis focuses on the role that the social connections inside the VW have on the participants' real world behaviour manifested through their technology practices in the classroom. At the start of the experience, as evidenced by the pre-test, the opinion of the participants was that learning technologies were complex, and that they were not confident enough to use them in class. They were also of the belief that they would not voluntarily offer to work with technology in the class. The self-reported data from the qualitative and quantitative approaches shows that these beliefs have changed over the course of PreVieW. The participants who were interviewed described their teaching experience after PreVieW as having offered a number of opportunities which they felt they would not have explored, had they not encountered them through the connections and networks which they formed in PreVieW.

6.2.2 Implications for the Integration of VWs in Teacher Education

The findings emergent from the qualitative data collected in this thesis that stand out the most, are those related to the participants' original perceptions of teaching, and their prior experience of learning, and how this changed following the brief engagement with the 3D VW. Through the various discussions it could also be observed that many of the participants started connecting what they had been covering in theory, such as the student-centred education, to the reality of their experience. There was a sense of surprise that cannot be fully captured within the transcripts of the interviews, but which reflected their newly formed perceptions of the true implications of a learner-centred education. More than one participant criticised the current and traditional form of lecture, where the educator takes on the centre stage and the students are expected to listen.

However, other interviewees reported that a number of participants in the VW who had opted not to participate in the focus groups, felt "lost" when trying to cope with this form of learning. Some participants were clearly not prepared to take full agency for their own learning because for them this experience was something which was

"new". In their terms, this was not part of their "culture" and this culture was not yet ready to embrace this way of working with technology. Many of the participants reported an initial sense of shock into this immersive way of learning. There were those participants who reported that they adapted to the situation quite quickly and the transition was smooth. However, there were those who reported, whether directly or through third parties, that the effort to adapt was too much – some reportedly having given up on understanding what was expected of them.

The participants however mentioned that the VW gave them an additional sense of presence, which was difficult for them to perceive achieving using any other Internet-based application. This sense of 'being there' as discussed in Chapter 3, was further supported by the rich capacity of the environment, in its multimodal presentation and the communication mechanisms. Participant interviewees remarked how during one specific event, where all the avatars were present, some had chosen to remain in the corridor leading to the main auditorium hall. Some of the participants got frustrated because they wanted to pass through and could not so they were urging the other avatars to move forward. For them, it was not enough to listen to what was being said. They wanted to be at the front to be able to see the speaker avatars, and to be able to meet their friends. This is something, which according to the participants could not be recreated using any traditional LMS.

A challenge which is encountered more frequently in teacher education, is the adaptation to new practices – a shift in the way pre-service teachers have been previously taught, and how they are expected to teach in response to societal changes and needs. This becomes especially problematic in the area of technology and digital practices. Findings have shown that learners still have preconceived ideas about the use and practice of technology in the classroom. Such priors can give rise to misconceptions about the complexity, and the perceived use of the technology practices. The pre-service teachers described how, following PreVieW, they changed their preconceptions of technology and its use, but most importantly they found their own individual ways of how they could apply it to the classroom teaching. Many of the interviewed participants experimented with some Internet-based applications during the six-week teaching practice following their VW experience.

In this thesis, learning technology acceptance and adoption by pre-service teachers is supported by providing the opportunities for them to construct a personal relationship between knowledge and beliefs through the applied group dynamics that are possible via the 3D VW medium.

Technology integration in teacher education should then facilitate the

1. experimentation with the application of technology practices in the classroom,
2. exploration of technology use and practices for learning,
3. design of opportunities that can lead to an individual's change in opinion or beliefs, and
4. creation of opportunities that can foster the formation of opinion or beliefs related to technology practices.

These practices, as has been demonstrated by research presented in Chapter 3 as well as the findings emergent from this thesis, can be highly influenced by communities and group formations. These communities would be sustained by their connectivity and would co-create a new common understanding, which is then shared within the virtual and social environment. However, it has also been demonstrated that such communities prove to be more influential in settings where the identities are more fluid and more pronounced. VWs, designed to bring together different identities in a setting that is rich in its multimodal display, are engaging through playful activities. Allowing learners to set their own learning targets can leverage the playful activities in such a way as to create more opportunities for engagement.

6.2.2.1 FRAMEWORK FOR THE INTEGRATION OF VWS IN PRE-SERVICE TEACHER EDUCATION

The insights gained from PreVieW led to the identification of the four main pillars for learning in VWs: experience, exploration, connections, and practice. Experiential learning is an important aspect of learning in a constructivist environment. The exploratory design brings out the sense of achievement through the participants' movements and creations in the 3D space whilst connections serve to strengthen

communities as components of social and collaborative learning. The way communities were brought together was through peer support as well as by giving advice on how to make use of resources to help them teach their subject of interest. The link between theory and practice is also an important aspect of teacher education. 3D VWs for teacher education need to be designed bringing elements of pedagogy and agency together in a practice-based approach applying the different tools, resources and modalities to classroom teaching.

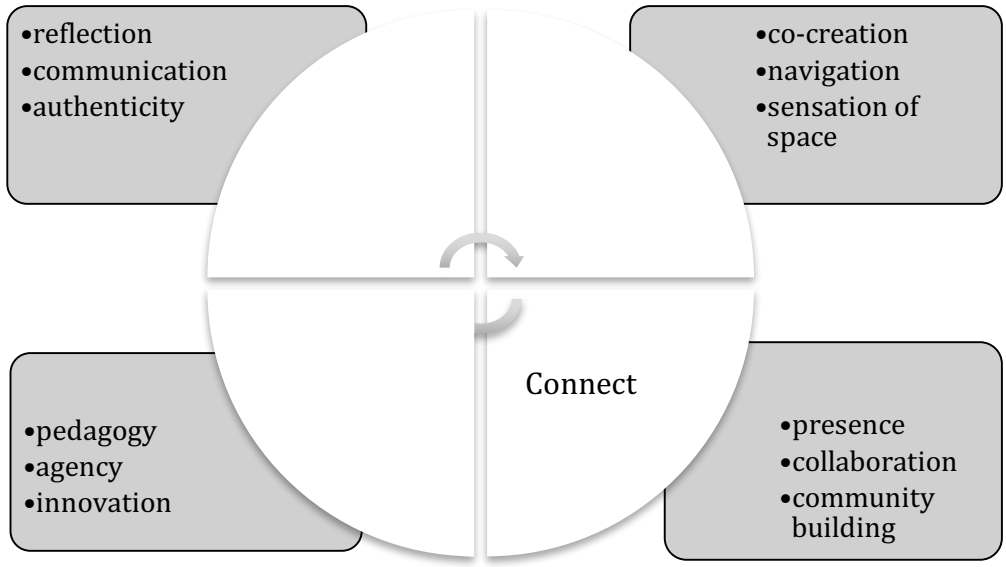

Figure 28 - Integration of VWs in teacher education - a macro-structure framework

The model above (Figure 28) proposes a framework for the integration of VWs in pre-service teacher education using four principles for learning. The principle of experience gives participants in VWs the space and the opportunity to reflect on and communicate about their experiences in an authentic setting. This leads to the principle of exploration that uses the elements of co-creation and navigation into the 3D space, to give the sensation of 'being there'. The VW will also facilitate and support various connections through presence, collaboration and building communities among avatars, as well as across external sources. The way that learning extends to beyond the immediate VW surroundings is by applying the principle of practice to the classroom pedagogy, taking agency of their own learning to come up with innovation in teaching practice.

6.2.2.2 INTEGRATING VWS IN TEACHER EDUCATION

The framework built around 4 pillars in learning leads to the emergence of 10 practical proposals for the design, development and use of a 3D VW as a learning medium in teacher education.

1. *Transitory and induction phases*: The quantitative findings in Chapter 5 indicate that there was a significant change in the participants' perceived complexity towards technology (>0.00). Qualitative findings show that one the themes emergent from the group interviews was 'self-perception'. This theme overlays perceptions related to individual learning styles and how these can be perceived as either aiding or hindering uptake of technology practices, as well as their notions of what constitutes a digital gap between themselves and the younger generation. From the qualitative data, there were strong indications the transition to move to a 3D VW medium was not easy and one which they had been previously exposed to. Culture, as is understood in this context, is the constructed meaning of what is real learning based on their previous experiences. For the participants to overcome the barrier to fully comprehend the implications of learning in a social VW there needs to be a period where they get accustomed to their virtual self, the expressive ability and to gain enough confidence to take agency of their own learning. Not all participants felt they gained much from the experience even though the pre- and post- experience surveys show that they have gained a more positive attitude towards technology and its use in their classroom teaching. Many of the participants reported a sense of being lost, and a sense that this was not directly attached to the reality. For this purpose, it is being proposed that before participating in the VW learning experience, each learner or participant goes through an induction phase, where they are given time and space to familiarise themselves with the VW and the different ways they can use it to express themselves in a social setting. In this thesis, an induction of two weeks prior to the start of the experience was carried out. Despite this two-week transitory period, there were still a number of participants who reported 'shock' because this was a unique experience and could, thus, not easily associate with. To further help the participants, a number of screen casts and a

guidebook were also made available through YouTube channels and the MOODLE VLE. Many reported that they found these extremely useful, more so because the way these were presented was in a format which they were used to, such as a YouTube video or a PDF note. This gave them a sense of familiarity with the medium which smoothened the transition.

2. *Identity formation and assertion*: A social VW needs to make provisions for the creation and customisation of avatars. The purpose is to allow participants to choose their virtual identities in such a way that they can identify with their virtual self. In this thesis, the participants could not take up fantastical or mythical creatures. The only avatar types available for customisation had human forms. However according to the data logs from the researcher, the participants still managed to make them look as much as themselves as possible. In one of the anecdotes from the researcher's logs, there was a particular instance during which they had actually made plans to dye their avatar's hair green so that a small group of them could easily be identifiable from the rest during the large group meetings. Their clothing, for the most part, was conventional too, and many opted for classic suits or casual wear as attire in the VW. This also shows that for the most part they were not yet ready to experiment with different, and maybe less conventional, avatars.

   Inside the VW the avatars were encouraged to take up a more active role, taking agency and control over their learning. To be able to do this, they need to be entrusted with a responsibility which they are comfortable to deal with as avatars. Such responsibilities can include the management of and active participation in small virtual groups or communities. In this thesis, each group was expected to name a group leader and a group presenter, whereas the rest of the members were expected to give contributions. The ways in which leadership is achieved in VWs that are also characterised by task completion and problem solving, is very much dependent on one's previous achievements, and on the sense of confidence which the participant is able to instil in others. In this thesis, the pre- and post- experience survey data did not result in any significant differences between gender, age or field of study. Yet the researcher's logs indicate that while group leaders tended to be male, more female avatars delivered their presentation during the VW information seminar. Although no detailed analysis was done on the actual role of males

and females in the VW, this tallies with other previous research work (Blascovich & Bailenson, 2011) that has been carried out on identity in VW and VR about gender, identity and power in a VE.

3. *Problem solving and task completion*: A VW that is constructed with no specific or direct purpose becomes for the most part uninhabitable and void of avatar life (Camilleri & Montebello, 2008). During the first focus group meeting, the participants mentioned that unless they had a specific task or mission to accomplish they did not feel any compelling need to visit and work inside the VW. Although the VW in itself was a novelty at the start and logging in was perceived as 'enjoyable' and 'fun', after some time other priorities, such as formal assessments and other course commitments took over. Many of the participants perceived their VW experience as fun, and therefore they believed that by logging in to converse was not as productive in terms of learning as traditional face-to-face lecturing environments. However, when tasks were assigned, the participants felt a drive to attend and present their work. Gameful activities also help to add more engagement to the tasks. The competition between the groups, and the prizes awarded for best presentations, also drove the groups to try harder to get to the hall of fame. Although the design of social VWs is around collaboration and communication, these cannot be the only drivers. Most often, having a problem to solve, engages the participants more deeply. This would serve to ensure more presence, more communication, and ultimately a richer learning experience. This thesis had distinct deadlines for task completion, allowing two to three weeks between each task. The findings from this thesis indicate that although the VW environment could provide elements such as authenticity, visibility of the work, creative freedom and a richer collaborative space, its technology is still not mature enough to provide for seamless transitions from the real world. The challenges that need to be overcome include the ease of use for the participants to participate and collaborate fully in VWs. The limiting factor present in the VW used in this thesis, included the difficulty faced by participants to create 3D objects in the VW, as well as upload content. A number of participants also had difficulty navigating, especially in the beginning and this limited their capabilities for participating fully in the collaborative tasks. The findings from this thesis suggest that

problem-based learning needs to be supported by a connectivist approach to learning, where the participants connect to various information sources held in the VW, as well as other avatars to co-create knowledge and solve problems.

4. *Co-creation and co-production*: The creation of content and VW objects serves to establish more propriety of the VW and to help individuals assume agency over their responsibilities by taking on a more active role in the VW. In the first instance, the participants experience the pragmatic dimension whereby they have to relate the virtual experience to their real world experience. In this thesis, the participants used themes, which were current to the expectations from their teaching practice. These included eLearning, as well as the use of social media and games in the classroom. On another aspect, it was very important for the participants to discuss these themes in relation to their subject. This was especially useful in the large group discussion where participants from the different fields of study could discuss aspects of the different subjects from the perspective of the teacher. This was something which they were not used to, and when they were asked to co-create learning objects, they combined the different fields to create one integrated resource. The second principle lies in the social and emotional dimension. This ties with the communities of practice and the social constructivism theories, as these propose learning which is ingrained in the social framework. In this thesis, emphasis was placed on the communication and interactions between the avatar participants. Social network analysis of the text-based interactions occurring in the VW show that patterns of connectivity between groups emerged from the various discussion-based activities held. The third principle is related directly to the usability and the human-computer interface, which the participants will use to co-create. In this instance, the use of a VW may not be the most simple user interface because the majority of the participants have never used such environments. In this thesis, a number of screen casts and guides were disseminated prior to the start of the experience. Participants were expected to explore features such as object creation in the VW individually. The fourth and last dimension is the hedonic aspect of co-creation. There is an element of pleasure and enjoyment in the co-creation, which is also mentally stimulating. In this thesis, the gameful activities leading to awards in the hall of fame helped achieve some of the pleasure gained in a healthy competitive

environment. Using peer feedback to give awards for best presentation also served to stimulate presenters and group members to participate in the tasks more actively.

5. *Moderated large and small group sessions*: During the in-world group focus session, it was suggested that large group sessions could be prone to large congestions, and to technical problems which would make it impossible for the participants to fully take part in what was happening. It was suggested that smaller, tutorial form sessions would be organised as part of the VW experience. When these were organised though, few people turned up as they thought these were less important than the actual large group game sessions. However, it is also important to point out, that for communities of practice in the VW to emerge participants need the time and the space to get to know each other. Most frequently, although the conversations are richer when held amongst larger groups, they gain more meaning when these are held in smaller groups. Discussions need focus and clear objectives and each different session needs to have its stated goals and expected outcomes. Managing sessions needs constant moderation and assistance. It is during these instances that many VW education leaders opt either for human or AI driven teaching assistants. Childs (2013), in his vision about the 'Future of Virtual Worlds', describes such a scenario where the class is alternated between the virtual and the real, where avatars and humans interact seamlessly and where each small group is led into a discussion by a virtual agent, who is not there to replace the teacher. The teacher, who is present throughout the experience, uses the time to mentor and to facilitate the discussions, especially when groups are visibly struggling to interact. The results show that whilst large group discussions are manageable, moderated small group discussions may be more effective to reach specific targets and target audiences. In this thesis, although small group discussions were encouraged, they were not moderated because of limitations in resources. For this reason, very few participants exploited the opportunity. This caused some inconvenience to those participants who preferred to have a more intimate discussion than that happening amongst 100 participants.
6. *Globalisation*: Although VWs use the dimensions of space and time in the relative immersive context, the notion of listening to 'foreign' speakers enticed the participants and motivated them to log in and take active part in

the discussions. VWs, like any other online medium, can be exploited to overcome geographical boundaries. However, the VWs give an added sense of presence through the embodiments of avatars. This facilitates a connection between avatars that strengthens the sense of belonging and community. In this thesis, two external speakers were invited to participate. One speaker was a professor from the Faculty of ICT at the University of Malta, whilst the second speaker was an academic from the KTH Royal Institute of Technology, Sweden. The feedback received from the participants proved to be very positive and both sessions were well attended. The notion of culture was also mentioned during one focus group session in relation to the external speakers. The participants enjoyed the possibility of extending their knowledge and network with persons who had different experiences and backgrounds to share. This exchange of cultural knowledge through the use of different media within the VWs is also part of the connective learning model that is proposed to describe the dynamics of social VWs in education.

7. *Timing and flexibility*: One of the feature characteristics of VWs is the persistence of environment. Although online learning environments are usually accessible on a 24-hour basis, the VW provides a 3D environment that allows for more flexibility in an authentic environment. In this thesis, many of the participants remarked that the experience gave them flexibility of learning through exploration at their convenience. The 3D space offers the participants the possibility of creating their own content, read through and review their peers' content in their own time. The virtual embodiment characteristic of VWs gives them the capacity of a space that extends the physical world whilst retaining the flexibility of the online environment. Many of the participants in fact remarked that having families whilst studying for a full time face-to-face PGCE course, was most time consuming, leaving little space for reflection. The VW gave them additional flexibility and space to allow time for reflection.
8. *VW feedback and support*: During the group interviews, the participants remarked about the importance of receiving constant feedback and support, especially in the first weeks of the experience. Because of their lack of confidence in their abilities and their initial perception about the complexity of the environment, without the necessary feedback and support they reported a

feeling of being 'lost'. The lack of experience of 3D environments and avatars made it difficult for most of them to be able to communicate effectively and to experiment with the affordances of the VW. The experience in this thesis, PreVieW, made use of avatar peers to give feedback to each other, and communities were encouraged to give each other support. Participant avatars were encouraged to join small group communities, to be able to complete the tasks assigned over the VW.

9. *Real world feedback and support*: During one of the feedback sessions with the participants, they indicated that although they coped with the experience, and pre- post-experience results show that there were significant changes in their attitudes towards technology acceptance, they still lacked the element of a face-to-face interaction. This also came out during the interviews, where many mentioned the importance for them to see the person behind the avatar and frame that individual in context. Although the flexibility of the online 3D environment was appreciated, importance was also given to face-to-face interactions, not just to overcome technical challenges but also to give the participants the opportunity to transition gradually from an environment, which by tradition would place the lecturer at the focus of the teaching, to an environment that requires the active participation of the learner.
10. *Technical and organisational support*: Technical challenges associated to VWs are not only relevant to the PreVieW experience. Research work conducted by Thackray et al. (2010) list a number of technical issues that still need to be overcome. Amongst these are the issues of bandwidth, hardware and cross compatibility across different devices and platforms. Most of the challenges mentioned by the participants include the technical difficulties that they experienced. Although the VW platform used for PreVieW was stable, it still required a computer with high graphics display. Not all Internet browsers were compatible with the VW platform and this limited access for some people. The integration of VW modalities in teaching and learning needs organisational support in terms of the provision of adequate bandwidth. Connecting over Wi-Fi may prove to be problematic, especially on a Campus because of the lack of adequate upload and download speed, unless dedicated channels are used. In PreVieW, most often such technical glitches led to an experience, which was not always satisfactory. Therefore it is being proposed

that before embarking on the use of such a modality, the necessary technical structure is in place in a way that can offer best support to people who may not always have their own personal devices capable of sustaining high graphic display or who may not have access to high speed Internet.

The 10 proposals above combine the insights gathered from PreVieW and the literature describing VWs in education leading to the emergence of a framework that combines all aspects discussed above for a more practice-driven approach.

6.3 Chapter Summary

This chapter has discussed the findings in Chapter 5 in relation to the body of academic knowledge surrounding the application of VWs to teacher education. Discussions included the key factors that have influenced a change in technology perception, the influences on learning and the role social connections in PreVieW play as well as the influences of the researcher roles. Applied strategies outlining the handling of the different roles within PreVieW were also discussed. The initial hypotheses, tested by quantitative methods, focused on the degree which PreVieW affected the pre-service teachers' perceptions about learning technologies, the factors and indicators that are most likely to contribute to this change and the changes in the formation of social groups in the VW over PreVieW's duration. However qualitative findings have built up on the initial hypotheses to understand how the experience itself affected the pre-service teachers and what design factors in turn affect this experience. A deeper understanding of these factors could lead to a better understanding of how VWs can be designed more effectively for teacher education programs. A discussion of these themes gave rise to a model which illustrated how PreVieW influenced the formation of beliefs about classroom learning technologies through the connections established with the avatars, and 3D objects present in the VW. A framework for the integration of 3D VWs as potential media for integrating learning technologies in the classroom is developed using 4 pillars of learning: experience, exploration, connections, and practice. Following these, 10 propositions for the integration of VWs in teacher education and more specifically to the application and acceptance of technology are outlined as a practical approach to the design, development and implementation of VWs for technology acceptance and adoption in teacher education.

CHAPTER 7

CONCLUSION

7.0 INTRODUCTION

In this thesis, a VW experience (PreVieW) has been designed and developed as a solution to overcome the challenge of technology acceptance and adoption in teacher education. The VW technology which offers immersion as its main characteristic, and learner-centric digital practices are merged together using the Exploratory Learning Model (de Freitas & Neumann, 2009) and Connectivism (Siemens, 2004) as concepts framing the overall investigation. The results indicate that following PreVieW, the participants report a change in perceptions about classroom learning technologies and further reflections indicate that the VW was responsible for that change in perception as well as for increased social collaborative practices in the use of learning technologies.

This chapter brings the thesis to a closure by presenting the implications of the findings in PreVieW for teacher education and recommending future directions in the design and development of VWs for education.

7.1 PREVIEW: IMPLICATIONS OF FINDINGS

In these past years the education landscape has been dominated by many changes, most of which involve the inclusion or integration of digital practices. Many higher education institutions are also opting for the online model as a means of course delivery. However such practices are not easily adopted and most frequently are met with a degree of resistance. In this modern era dominated by social computing, knowledge processing has become more interactive and dependent on community building, experience and experimentation. Such needs prompt for alternative modalities and models that can support a more innovative approach towards learning.

This thesis uses the Exploratory Learning Model for the design of the 3D immersive technology and Connectivism for the design of learning activities in the VW to affect user behaviour towards classroom learning technologies.

As a result of this thesis, the participants have reported a stronger sense of self-belief about their use of classroom learning technologies emerging from the online VW dynamics. Exploration, experimentation and connection with others were factors involved in the dynamics leading to a change in the participants' perceptions about learning technologies. From the data it has emerged that whilst technical issues were considered a challenge, the student participants had the possibility of applying many of the practices which they experienced in PreVieW to their teaching due to their increase in confidence in the use of different learning technology techniques and applications.

The data collected also shows that the technology itself helped the participants not only identify and connect with the VW space, but that the design of the tasks inside the VW helped them form collaborative communities that supported exploration and a practice-based approach.

The implication for teacher education is that 3D VWs need to be designed in ways that would bring together communities through tasks that foster creation through collaboration. The process of designing the course content and the VW user interface in parallel is used to limit threats to PreVieW. On the one hand, when one starts by translating formal curricular content for an alternative medium of transmission, there is the risk that one might not take into account all the affordances of the technology that can be exploited, focusing more on the content instead. On the other hand, if one starts with the development of the technology, one runs the risk of focusing more on the affordances of the technology rather than pedagogic needs of a higher education course.

Therefore, one starts by establishing the primary scope, target audience and goals of the learning experience. It is from this that both content & VW are developed in parallel. However, the user design in the VW also serves to create social connections to help build the community and support the pre-service teachers for the acceptance and adoption of learning technologies. The elements of design of PreVieW have included openness and flexibility, as well as co-creation and navigation through the virtual space.

Social network analysis showed that socio-collaborative learning activities contribute to increased interactions (in the form of text-based messages) in the VW. However whilst such analysis may indicate the formation of communities, findings show that changes in perceptions and attitudes towards technologies are not affected by the amounts of interactions one has in the VW. This might imply that the setting itself, the tasks and their outcomes and the active role taken by the student participant are major contributing factors to the changes in perceptions about classroom technologies.

The findings have demonstrated that the transition from the real to the VW is not an easy one for the participants to handle. The traditional teaching methods, which they are used to have a strong influence on the way they have been learning. When learning inside the VW does not mirror past experiences and does not attempt to recreate the physical class, there is shock and confusion arising from uncertainty. This uncertainty whilst leading to the acquisition of new knowledge is not always accepted by learners in the same manner. There are learners who would need more time and a more gradual transition to a form of learning that is more dependent on their active involvement. Change is therefore forthcoming in small steps. The translation of the behaviour from the VW to the real world emerged through their collaborative outcomes. The participants showed a change in attitude but they also had the opportunity to reflect on their understanding and perception of their abilities outside the VW. This also implies that the opportunity to practice in what they consider to be a 'safe' environment, amongst peers with the same ability but coming from different areas and fields of study, is not only encouraging but it also increases the motivation to perform better.

The indications from PreVieW are that changes in attitude and perceptions towards technology acceptance can be facilitated with the inclusion of VWs in pre-service teacher programs. However the effectiveness is influenced by the degree of integration of VWs in teacher education programs and their design. Findings indicate that should VWs be designed and developed for experience sharing or resource building only on a voluntary participation basis, learners will not necessarily be motivated to exploit them. When assessed tasks were included in the VW activities during PreVieW, participants showed more motivation to participate and perform well. With the addition of game dynamics, participants displayed deeper engagement.

It is therefore being proposed that VW modality is included as part of the assessed teacher education curriculum, giving more opportunities to all the pre-service teachers to find the space, time, opportunity and means to grow professionally through their connectivity with the VW.

Further analysis has shown that the participants felt that they had experienced the meaning of student-centred learning. The implications from these findings are that VWs can be used to link theory to practice in different ways; role plays can be used to support classroom management and practice, social roles can be facilitated through the avatar identities, and self-belief can be augmented through experience, exploration and connectivity whilst reflection can be achieved over the shared 3D immersive spaces. The future is not bleak for VWs and they certainly hold a distinct place in higher education. The vocational professions that require the ability to work in a community and deal with innovation can greatly benefit from the use of such spaces in their instructional programs. However, there is still much need for further studies and improvements to the development of VWs.

7.2 Future Research & Development of VWs in Education

The findings from PreVieW suggest that the use of VWs in education may be exploited in different ways. Teachers who may not have been exposed to different technologies, applications and practices would have a limited view of how these can be applied to their classroom practice. Pre-service teacher education programs aim to include content that may help teachers acquire such knowledge and skills. However including content in the traditional lecture format may not be effective to change attitudes towards the adoption of digital practices in the classroom. There is space for further research into the area. To date there are very few empirical research studies that compare the effectiveness of using the VW modality with a blended or a face-to-face modality in terms of a design based on social learning theories, exploring social constructivism, communities of practice and connectivism.

There is also little evidence providing an understanding of the depth of learning through the application of VWs. There are indications that participants who have had exposure to modalities built around experience, exploration, connectivity and practice may display a deeper engagement with the content. In this way, the learners might be

intrinsically motivated to keep creating connections for and around the particular study domain, long after the VW has expired. This self-reliance and autonomy leads to further exploration and discovery that is authentic in the context in which it is framed. For this purpose there needs to be research that is longitudinal across a longer period, where the learners would have more opportunity to recreate connections themselves and make use of the experiences built inside the VWs. Research is still far from providing hard evidence that VWs and games can actually improve attainment. Though empirical evidence may be criticised in terms of the identification of more authentic forms of learning, it is needed as a grounding that provides the justification for more research in the area. It is important to develop research that is also more analytic in the way the different elements come together for a learning experience.

Data analytics is also in its infancy and there needs to be a deeper exploration about how this can be made use of in VWs to provide on-going support to the participants during their virtual experience. In this thesis, certain patterns about communities emerged from the number of text-based interactions and connections between the avatars. Future work may include the discourse analysis of the conversations held in VWs to be able to capture the tacit knowledge in a more structured manner and channel it as explicit knowledge through the communities formed.

There is also scope for research into the interface design for VWs. Co-creation is an important element in the domain of exploration. Through co-creation and navigation, the learner can achieve a stronger sense of presence inside the VW. This sense of 'being there', can lead to a deeper immersion that can stimulate further motivation. VWs, at present, offer many challenges to learners, amongst which is the difficulty to connect resulting from Internet bandwidth, hardware and software requirements, as well as the difficulty in creating VW objects. All this limits the sense of presence in the world and increases the gap between the virtual and the real. By internalising the means to interact better with the VW, its contents, and other avatars, the learner inside the world assumes ownership of the context and is better able to transform it into an opportunity for learning.

The research design is also such that expected outcomes of this research would give indications about how the design used in PreVieW might impinge on the user behaviour in the real world in different fields of study, such as youth studies,

psychology, diplomatic studies, etc. Cross-disciplinary research using the dynamics of belief formation as proposed in the Connective Model (Figure 27) and conceptualised in the macro-structure framework (Figure 28) can add value to the future development of VWs in the broader scope of higher and further education.

7.3 Chapter Summary

This chapter discussed the concluding thoughts about this investigation by reflecting about the journey undertaken focusing on the problem and on the proposed solution found in using VWs as a medium to help influence user perceptions, in a way that can modify real world behaviour. This thesis has shown that VWs have a role in teacher education programs by supporting pre-service teachers in overcoming challenges associated to classroom technologies acceptance and adoption. The outcome from the findings has shown that a number of factors are responsible for the change in user behaviour towards learning technologies. These factors include the immersive and authentic setting, the social connections mediated by the 3D environment and the possibility of practicing in a safe environment. The statistical analysis performed on the data collected showed that PreVieW has positively influenced the participants' perceptions of classroom technologies, the data logs demonstrated that planned group activities increase user interactions in the VW, whilst the qualitative data showed that the participants assimilated the experiences in the VW and transferred them to their real world teaching practices. The conclusions drawn have shown that the aim and objectives of this research have been successfully met through the in-depth investigation about the effects of a social 3D VW on pre-service teachers' perceptions about classroom technologies. A measure of the participants' perceptions about learning technologies has been presented using the pre- and post- experience survey results whilst a visual representation of the social interactions between the learners inside the VW has emerged from data logs collected. The identification of a learning model and a number of propositions for the design and use of a 3D VW in a teacher education program provide a contribution to the growing body of research on educational models for VWs, with practical implications for use of VWs in Teacher Education Programmes.

"I believe that the virtual connections we make, shape who we become, irrespective of how we were taught - that is my hope for the future of teacher education"

The Author

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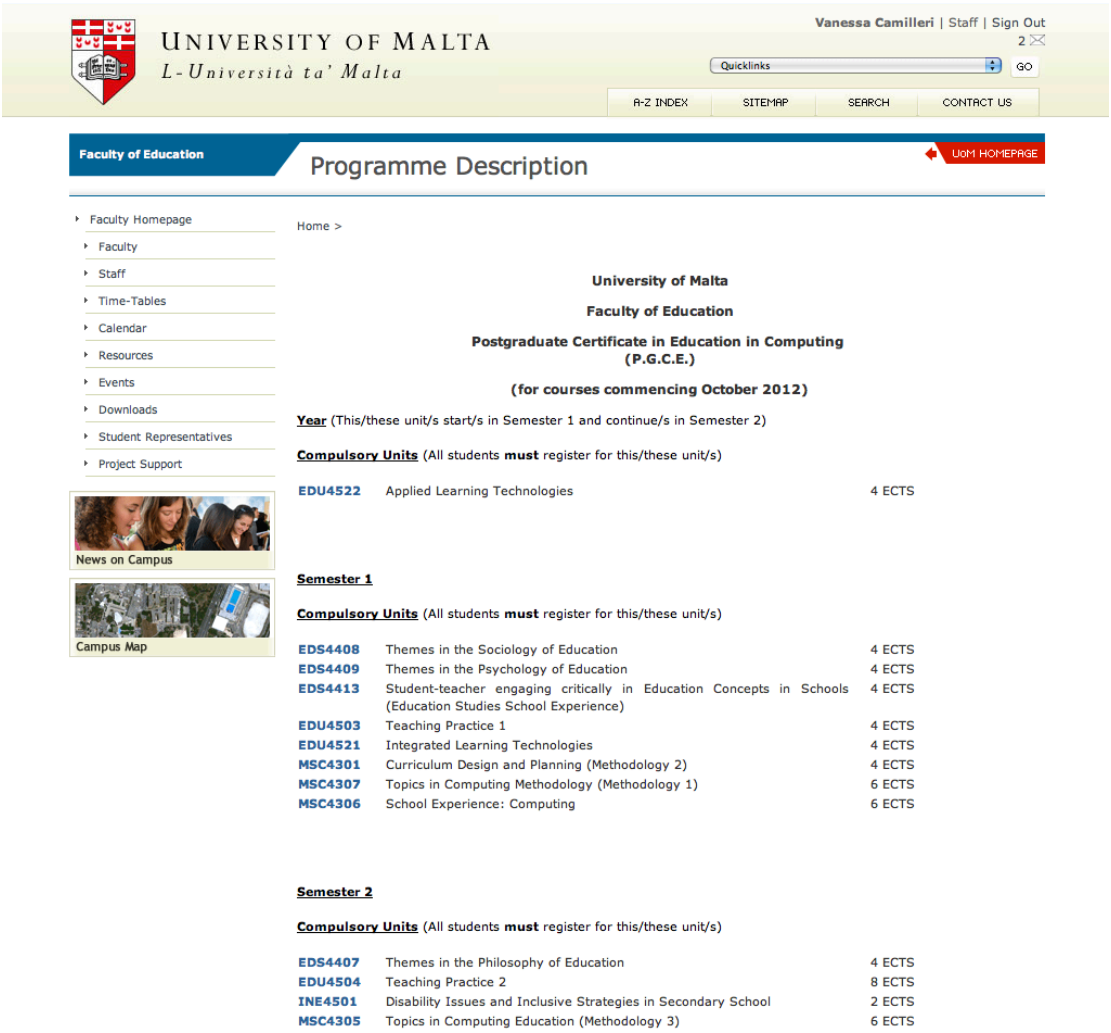
APPENDICES

APPENDIX 1: PGCE – PROGRAMME DESCRIPTION

2012/2013

This is a sample description of the programme for the PGCE in Computing for the academic year 2012/2013. Different subject area strands follow the same compulsory units shown below. The integrating learning technologies study unit which was adapted for the 3D VW can be seen under Compulsory Units for Semester 1, carrying the code EDU4521. A more detailed description of the study unit follows in Appendix 2.



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University of Malta

Faculty of Education

Postgraduate Certificate in Education in Computing (P.G.C.E.)

(for courses commencing October 2012)

Year (This/these unit/s start/s in Semester 1 and continue/s in Semester 2)

Compulsory Units (All students **must** register for this/these unit/s)

EDU4522	Applied Learning Technologies	4 ECTS

Semester 1

Compulsory Units (All students **must** register for this/these unit/s)

EDS4408	Themes in the Sociology of Education	4 ECTS
EDS4409	Themes in the Psychology of Education	4 ECTS
EDS4413	Student-teacher engaging critically in Education Concepts in Schools (Education Studies School Experience)	4 ECTS
EDU4503	Teaching Practice 1	4 ECTS
EDU4521	Integrated Learning Technologies	4 ECTS
MSC4301	Curriculum Design and Planning (Methodology 2)	4 ECTS
MSC4307	Topics in Computing Methodology (Methodology 1)	6 ECTS
MSC4306	School Experience: Computing	6 ECTS

Semester 2

Compulsory Units (All students **must** register for this/these unit/s)

EDS4407	Themes in the Philosophy of Education	4 ECTS
EDU4504	Teaching Practice 2	8 ECTS
INE4501	Disability Issues and Inclusive Strategies in Secondary School	2 ECTS
MSC4305	Topics in Computing Education (Methodology 3)	6 ECTS

APPENDIX 2: STUDY UNIT DESCRIPTION

This is general study-unit description for EDU4521 – Integrated Learning Technologies, which was then adapted to the 3D VW environment. Although the VW model adhered to the general aims and objectives of the study-unit, specific aims and target outcomes were designed in line with the features and characteristics supported by the 3D VWs for participant engagement.

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CODE EDU4521

TITLE Integrated Learning Technologies

LEVEL 04 - Years 4, 5 in Modular UG or PG Cert Course

ECTS CREDITS 4

DEPARTMENT Faculty of Education

DESCRIPTION

What does communication and collaboration in learning mean in the digital age? What are the implications of digital tools on the way we teach and learn? How does all this impinge on the way our future society will communicate and interact? Which pedagogical scenarios are mediated by different forms of technology? Most important, how are different modes of learning promoted by different digital tools and environments?

These are important questions which this study-unit aims to tackle. Some of the most promising innovative practices involve the correct use of the digital tools which are easily accessible and available. However the use of such tools, has also ushered the need for teachers to develop skills which go beyond the mere use and focus more on the critical application of these tools within the classroom practice. For schools to lose this "digital disconnect" (Taranto, 2011) between what is happening in the classroom and what actually goes on beyond the classroom, teachers need to internalize the approach to learning which the 21st century digital society is adopting. Using the TPACK Framework Model approach (Abbitt, 2011; Mishra & Koehler, 2006) this unit looks at integrating technological pedagogical content knowledge with 21st Century skills thus ensuring a comprehensive approach to Education which impinges on the future application of technology both within in the classroom context and beyond.

The unit will start off with a conceptualization of the meaning of learning in the 21st century, moving on towards different approaches, methods, tools and applications which can be used to engage learners in the interactive, collaborative learning environment and a discussion of best practice for the integration of learning technologies in the classroom context.

This will be achieved through the:
- use of the online environment to support the face-to-face interactions during the classroom sessions;

This will be achieved through the:
- use of the online environment to support the face-to-face interactions during the classroom sessions;
- extension of discussions and collaborative activities beyond the classroom;
- active participation of the learners in the classroom context;
- peer and collaborative structures to facilitate reflection and a critical analysis of the tools and applications for learning which are accessible over the online environment.

This study-unit will also give the learners the possibilities to reflect and discuss issues which impinge greatly on the future society, such as those which include ethical considerations as well as accessibility factors.

Study-unit Aims

This study-unit will provide guidance and support for pre-service teachers in the uptake and adoption of learning technologies in the classroom, through a series of face-to-face and online interaction processes, directing learner perceptions and self-efficacy values towards the benefits of technology-enhanced modalities for teaching and learning.

Learning Outcomes

1. Knowledge & Understanding:
By the end of the study-unit the student will be able to:

1. Identify digital tools and applications that can be used to facilitate and support active learning practices;
2. Discuss technology-based practices and methodologies that can be used to stimulate and engage learning ;
3. Collect, collate, filter and harvest information in context using the online environment;
4. Demonstrate collaborative skills through the use of Web2.0 tools;
5. Review and compare different approaches and methodologies to the integration of learning technologies in the classroom context.

2. Skills:
By the end of the study-unit the student will be able to:

1. Present thoughts and reflections to peers and colleagues in an oral and written form;
2. Use the online environment in a safe, responsible and ethical way in full respect of the course participants and the general community;
3. Collaborate in groups, during face-to-face and online interactions, in a spirit of sharing of resources and experiences;
4. Interact and actively participate in their own learning through the various tools and applications presented;
5. Demonstrate initiative and innovation in being able to find different approaches, methodologies and best practice for the integration of learning technologies in their individual subject areas.

Main Text/s and any supplementary readings

Roblyer, M. Doering, A. 2010. Integrating Educational Technology into Teaching. Pearson Education, Inc. Boston, USA ISBN 978-0-13-513063-6

Maloy, R. W. Verock-O'Loughlin, R. Edwards, S.A. Park Woolf, B. 2011. Transforming Learning with New Technologies. Pearson Education, Inc. Boston, USA ISBN 978-0-13-159611-5

APPENDIX 3: TIMELINE OF PREVIEW ACTIVITIES

Below is the table of activities planned for the PreVieW experience in relation to the study unit delivered: EDU4521

Date	Activity	Description
05/10/2012	Account Creation	An account is created for all the participants. Information is sent via email. Users are expected to follow the email instructions to agree to the conditions, set up their profile and customise their avatar.
06/10/2012 – 17/10/2012	Orientation	Participants are expected to log in and familiarise themselves with the VW and their avatar. Tutor will be present in-world during specific times of the day/night to give support as required.
13-20 October 2012	Connecting In-World	More participant discussions are encouraged. A guest speaker seminar is scheduled for the 18th October at 2100. This seminar is intended to test out PreVieW with the 111 participants before the participants start their in-world tasks.
18/10/2012	Guest Talk	A talk is planned to be held in world as part of the familiarisation process. During this talk, the participants are expected to listen in and follow. This talk has been planned to help students identify any technical or user interface difficulties. During the talk, voice communication and interactions over text-based chat are encouraged. This talk was promoted in the VW [See poster in Appendix 4]
29/10/2012	Information Seminar	This is the first planned information

	#1	seminar which is led primarily by the students. The tutor introduces the session, the participating groups and moderates the discussion sessions. The participants have been asked to join groups and carry out some tasks in-world. During the information seminar the participants are asked to present their work to the rest of the groups. A competition is set up for the best group presentations. The first three have their work displayed at the entrance of the VW.
06/11/2012	Pre-information Seminar	A short preparatory session to familiarise the participants with the new world. The participants are briefed and then they are given time and opportunity to visit the new world and discuss the themes featuring in this world.
15/11/2012	Information Seminar #2	The second planned information seminar is also student led. The tutor introduces the session, the participating groups and moderates the discussion sessions. Groups previously established compete against each other, carrying out tasks given out by each other.
11/12/2012	Information Seminar #3	This seminar follows a world café format. A second guest speaker is invited to give a short 30 min talk to the participants. The participants then split up into groups and find a space in the VW. They have a sub-topic to discuss. Following the discussion they are then invited to join together as a large group to present their discussion

		points and proposals.
19/12/2012	Tutorial Seminar Paper	This tutorial is meant to guide the participants in the writing of the seminar paper, which is expected as part of the overall study unit assessment. Participants can ask questions, and are also expected to discuss their ideas, and the draft of their paper with their peers for feedback.
21/12/2012	Information Seminar #4	The fourth seminar also follows the format of the previous seminars that are participant led. Each group prepares a presentation based on the outcomes of their tasks. This presentation is done in front of the peers, where each group is expected to give feedback.
13/01/2013	Tutorial Seminar Paper #2	A seminar held in the 4th VW for those who would need some additional guidance in the presentation of their seminar paper as part of their overall study-unit assessment.

APPENDIX 4: PREVIEW ACTIVITY INFORMATION

Figure 29 - Poster Guest Talk

Figure 30 - Information Seminar #1 Leaflet – page 1

Figure 31 - Information Seminar #1 Leaflet – page 2

Figure 32 - Information Seminar Guidebook - page 1

Figure 34 - Information Seminar Guidebook - page 3

Figure 35 - Information Seminar Guidebook - page 4

APPENDIX 5: PREVIEW DOCUMENTED EXPERIENCES

Consent was obtained from the participants for the recording of scheduled talks and information seminars to be made available after the session upon the creation of the VW user profile.

INFORMATION SEMINARS

Figure 36 - Information Seminar #1: 29th October 2012

Figure 37 - Information Seminar #2: 15th November 2012

Figure 38 - Information Seminar #3: 11th December 2012

Figure 39 - Information Seminar #4: 21st December 2012

Figure 40 - Pre-information Seminar: 6 November 2012

Figure 41 - Tutorial Seminar Paper: 19th December 2012

GUEST SPEAKERS

Figure 42 - Guest Talk - The Semantic Web: 18th October 2012

Figure 43 - Guest Talk – Social Media in Education: 11th December 2012

APPENDIX 6: STATISTICAL ANALYSIS IN PRE- POST- SURVEY

Table 23 - Correlations between dimensions of the technology perceptions indicators adapted from TAM (Teo, 2009) (n=74)

		Perceived usefulness	Perceived ease of use	Attitude toward using the Internet	Behavioural Intention	Perceived Complexity	Experience	Voluntariness
Perceived usefulness	Correlation	1	0.286	.158	.401	-.194	.225	-.067
	P-value		0.01	.18	.00	.10	.05	.57
Perceived ease of use	Correlation	0.286	1	.471	.601	-.164	.635	-.104
	P-value	0.01		.00	.00	.16	.00	.38
Attitude towards using the Internet	Correlation	0.158	0.471	1	.534	-.037	.363	.059
	P-value	0.18	0.00		.00	.76	.00	.62
Behavioural intention	Correlation	0.401	0.601	.534	1	-.224	.551	.030
	P-value	0.00	0.00	.00		.06	.00	.80
Perceived complexity	Correlation	-0.194	-0.164	-.037	-.224	1	-.273	-.115
	P-value	0.10	0.16	.76	.06		.02	.33
Experience	Correlation	0.225	0.635	.363	.551	-.273	1	.000
	P-value	0.05	0.00	.00	.00	.02		.99
Voluntariness	Correlation	-0.067	-0.104	.059	.030	-.115	.000	1
	P-value	0.57	0.38	.62	.80	.33	.99	

The data in Table 23 shows an overall significant correlation between a number of dimensions within the technology acceptance model. Any p-value less than the 0.05 criterion shows that there is a positive correlation between two dimensions.

The correlation results show a positive correlation between perceived usefulness and perceived ease of use, behavioural intention to use Internet applications, and experience in handling Internet applications. There is also a positive correlation between perceived ease of use and perceived usefulness, attitude towards the use of Internet applications, behavioural intention to use Internet applications, and experience in handling Internet applications. 'Attitude towards the use of Internet applications' is positively correlated to 'perceived ease of use', 'behavioural intention to use Internet applications' and 'experience in handling Internet applications'. The 'behavioural intention to use Internet applications' is positively correlated to 'perceived usefulness', 'perceived ease of use', 'attitude towards the use of Internet applications' and 'experience in handling Internet applications'. The 'perceived complexity of Internet applications' is positively correlated to 'experience in handling Internet applications'. The 'experience in handling Internet applications' is positively correlated to 'perceived usefulness', 'perceived ease of use', 'attitude towards the use of Internet applications', 'behavioural intention to use Internet applications' and 'perceived complexity of Internet applications'. The participants' 'voluntariness in using the Internet' is the only dimension that is not significantly correlated to any other dimension.

Following the correlations of the technology acceptance variables to age, gender and field of study, a factor analysis is carried out to identify the correlation between the complete variables in the data set, in terms of a smaller number of latent variables. This would identify which one/s of the variables are responsible for the variance of the data. One popular method for carrying out factor analysis is the principal component analysis to determine which component/s are responsible for the skewness of the data.

Table 24 – Communalities from the Principal Component Analysis

	Initial	Extraction
Perceived Usefulness of Internet Applications	1.000	.536
Perceived Ease of Use	1.000	.727
Attitude towards Using the Internet	1.000	.690
Behavioural Intention to use the Internet	1.000	.726
Perceived Complexity using the Internet	1.000	.771
Experience	1.000	.616
Voluntariness in Using the Internet	1.000	.882

Extraction Method: Principal Component Analysis.

The communalities are the sum of the squared component loadings. Each communality represents the amount of variance in the variable accounted for by all the components identified. In the case of the 'perceived ease of use of Internet applications' the three extracted components account for 72.7% of the variance.

Table 25 - Total variance explained using Principal Component Analysis

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.843	40.610	40.610	2.843	40.610	40.610
2	1.104	15.770	56.380	1.104	15.770	56.380
3	1.001	14.301	70.681	1.001	14.301	70.681
4	.797	11.390	82.071			
5	.571	8.153	90.224			
6	.353	5.045	95.269			
7	.331	4.731	100.000			

Extraction Method: Principal Component Analysis.

From the seven components extracted, it has been established that component one accounts for 40.61% of the variance. This is considered to be the principal

component. Together with ‘perceived ease of use’ and ‘attitude towards the use of Internet applications’, as the second and third principal components, it accounts for 70.68% of the total variance of the data. Only the first three principal components have an eigenvalue which is greater than 1 (2.843, 1.104, 1.001). The scree plot in Figure 58 suggests that the three components are needed.

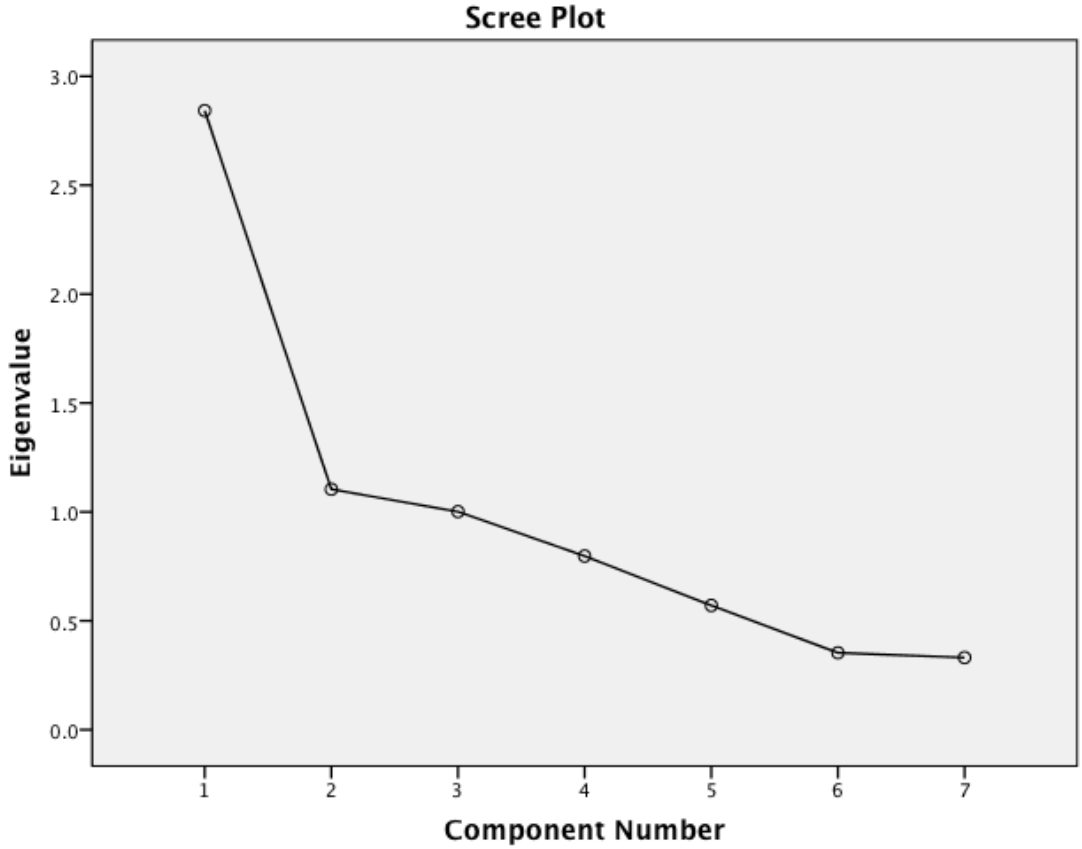

Figure 44 - Scree plot for the accountability of the components of the variance in the results

The component matrix below, displays each variable's loading on the components. Table 27 below shows that the 'perceived complexity using the Internet' and 'voluntariness in using the Internet' do not load on the first component (which is the strongest component without rotation). 'Perceived usefulness', 'perceived ease of use', 'attitude', 'behavioural intention' and 'experience' all loaded strongly on component one whilst 'perceived complexity' loaded on component two and 'attitude', 'perceived complexity' and 'voluntariness' loaded strongly on component three.

Table 26 - Component matrix[a]

	Component		
	1	2	3
Perceived Usefulness of Internet Applications:	.504	.012	-.531
Perceived Ease of Use	.827	.193	.069
Attitude towards Using the Internet	.662	.109	.489
Behavioural Intention to use the Internet	.849	.001	.068
Perceived Complexity using the Internet	-.359	.617	.511
Experience	.784	-.030	.020
Voluntariness in Using the Internet	-.008	-.820	.457

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

To enable a different perspective and an interpretation of the factors responsible for the skewness of the data, a varimax rotation technique is applied to the principal component analysis. This type of rotation is a change of coordinates that attempts to maximise the separation of the high and low loadings on each factor. Although the relationship between the variables and the components remains the same, the test axis that describes them is altered to provide for a different interpretation of the factors.

Table 27 – Total variance explained using varimax rotation

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.843	40.610	40.610	2.567	36.673	36.673
2	1.104	15.770	56.380	1.300	18.576	55.249
3	1.001	14.301	70.681	1.080	15.432	70.681
4	.797	11.390	82.071			
5	.571	8.153	90.224			
6	.353	5.045	95.269			
7	.331	4.731	100.000			

The table above shows that three components have eigenvalues greater than 1 using the varimax rotation. These three components are cumulatively responsible for 70.68% of the total variance. Component 1 is responsible for 36.73% of the variance whilst components 2 and 3 are responsible for 18.58% and 15.43% respectively.

In Table 31, using the rotated component matrix, the variable loadings on the different components are in agreement with the principal component analysis performed without rotation.

Component 1 is primarily affected by the 'perceived ease of use' (81.8%), 'behavioural intention' (80.7%), 'attitude' (80.1%), and 'experience' (72.5%). Component 2 is affected by 'perceived usefulness' (59.9%) whilst component 3 is affected strongly by 'voluntariness' (93.7%).

The amount of variations explained by the three components in both the component matrices (without rotation and with varimax rotation), are for the greater part in agreement. Component 1, which is responsible for approximately 40% of the total variance, is mostly affected by the participants' 'perceived ease of use', their 'behavioural intentions', the 'attitude towards the use of Internet applications', and the 'experience' they reported.

Table 28 - Rotated component matrix[a]

	Component		
	1	2	3
Perceived Usefulness of Internet Applications:	.279	.599	-.315
Perceived Ease of Use	.818	.168	-.171
Attitude towards Using the Internet	.801	-.178	.130
Behavioural Intention to use the Internet	.807	.274	-.009
Perceived Complexity using the Internet	-.050	-.844	-.237
Experience	.725	.302	-.005
Voluntariness in using the Internet	.021	.055	.937

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 4 iterations.

APPENDIX 7: SNA GRAPHS FOR PRIVATE TEXT-BASED INTERACTIONS

The visualisations in this appendix present the private text-based interactions in PreVieW during the period October 2012-December 2012. As can be noticed, in the private text-based interactions the researcher held a more central role in PreVieW for October 2012 but the centrality of the connection lessened during November and December 2012.

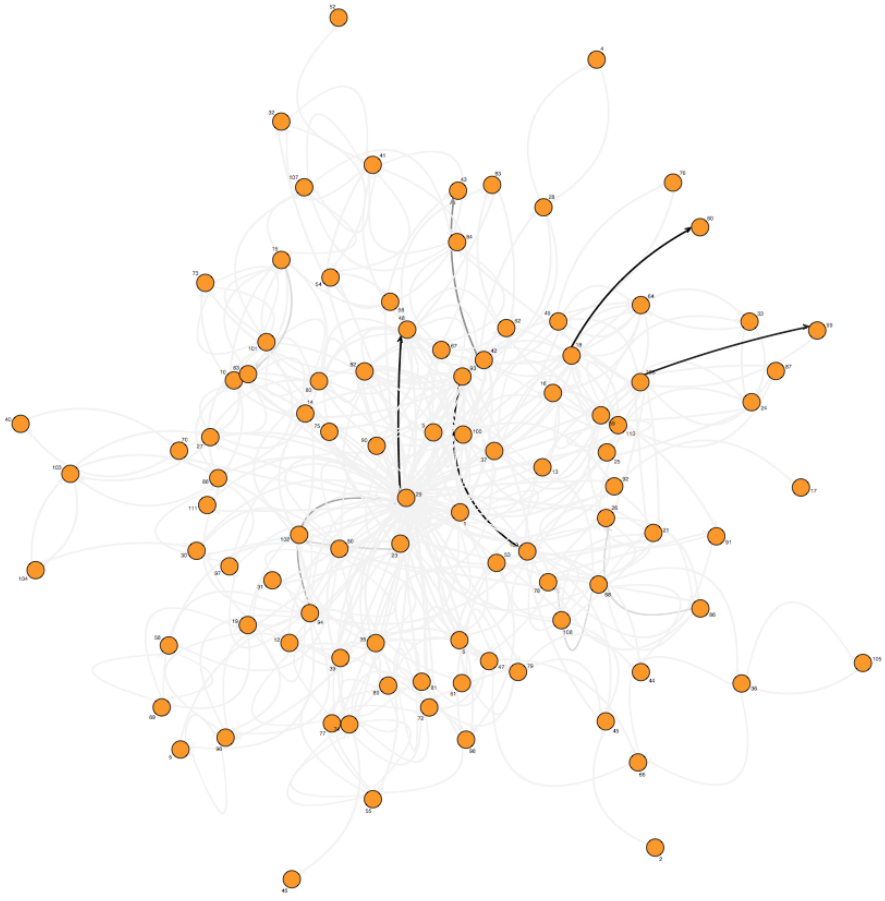

Figure 45 - A social network analysis graph using RStudio for private text chats between participants during the month of October 2012

In Figure 48 above, for private text-based conversations, the node with the most prestigious score in October 2012 belonged to the researcher. This is indicated by the centrality of the node and is reflected from the amounts of conversations the participants had with the researcher, as a mentor/guide during the experience. Figure

48 indicates that although many of these text-based discussions centred around the researcher, other small clusters were formed between individual participants who interacted privately. During November no central node was established as shown in Figure 49. This indicates that private conversations were held between several participants, but that no participant referred to another individual on a more frequent and recurring basis.

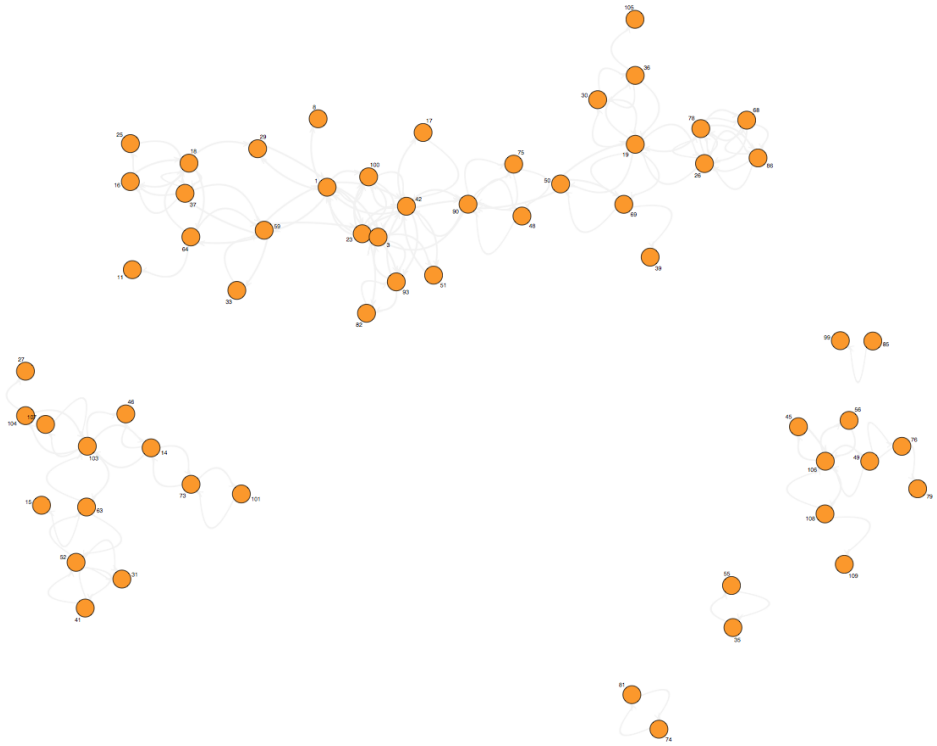

Figure 46 - A social network analysis graph using RStudio for private text chats between participants during the month of November 2012

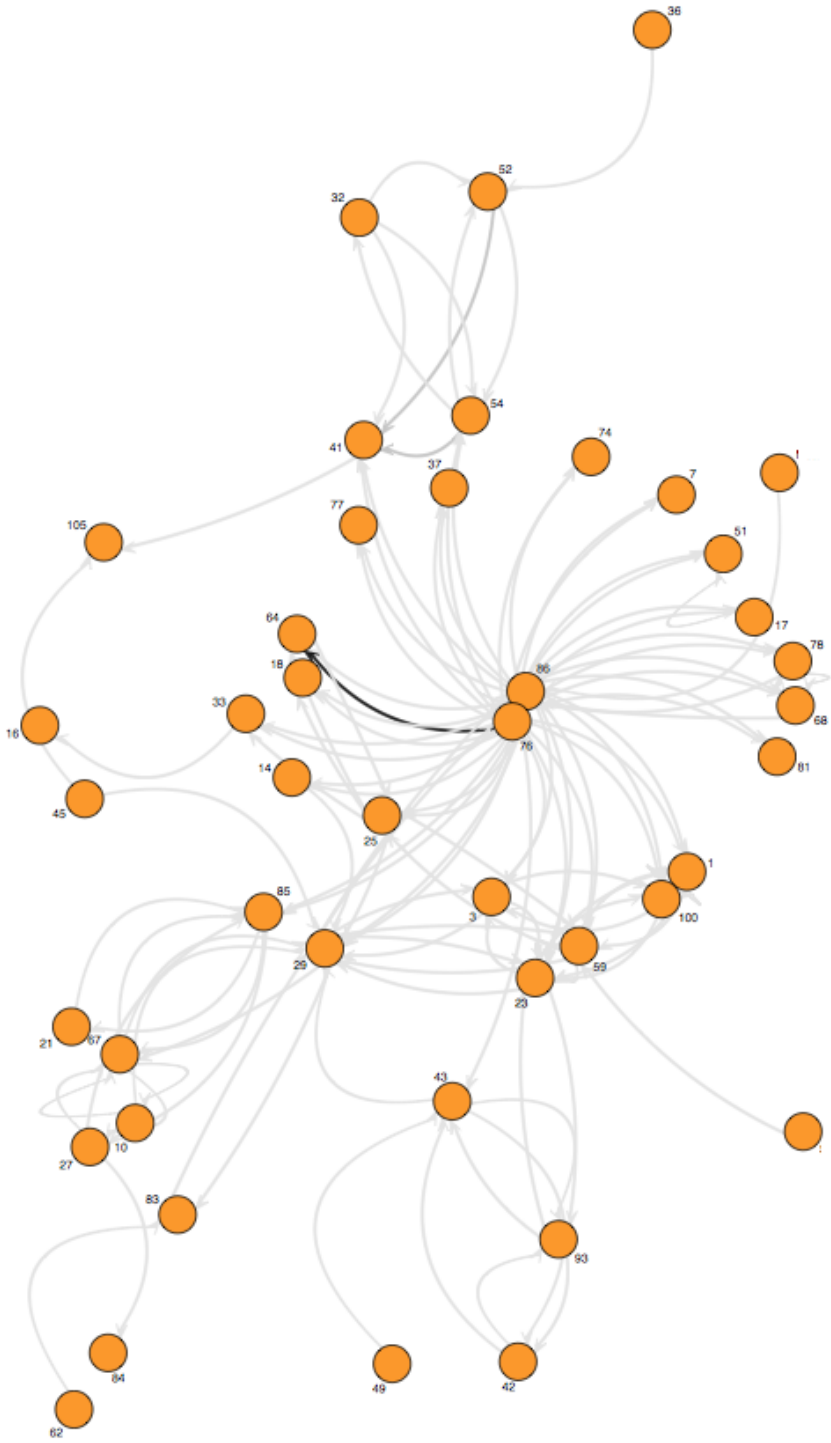

Figure 47 - A social network analysis graph using RStudio for private text chats between participants during the month of December 2012

In December 2012 (Figure 50), two central nodes emerge from the graph indicating that two participants carried the more prestigious scores as a result of having sent and received more text-based private messages than other participants. Nodes held at the

periphery show that whereas participants connected to each other, they did not always connect to one specific participant and the connections established were not repeated.

Participants could also choose to communicate using a private chat system. An analysis of the private text chats between the participants during the four weeks in October 2012 shows that the networks formed between groups of two participants undergo a transition during the recorded period. During the first week (Figure 51) the researcher (ID:29) establishes a central role in the network as participants refer to her as a tutor during their learning journey.

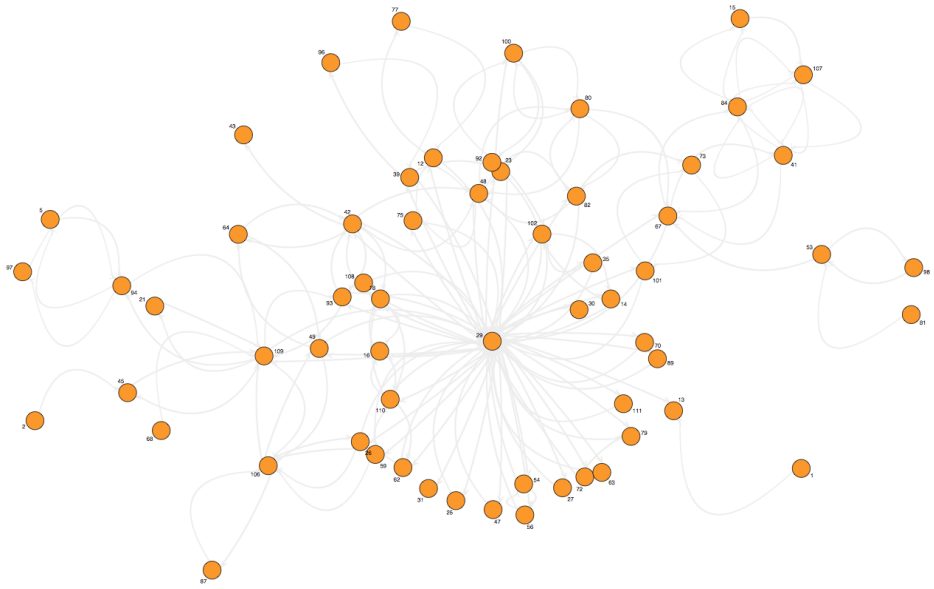

Figure 48 - A social network analysis graph using RStudio for private text chats between participants during week 1 in October 2012

During the second week, the researcher shifts the centrality of her role slightly as the participants take their time to get to know each other. This can be seen from the dispersion of the nodes in Figure 52. It can also be seen that there were no two participants who spent more time communicating with each other than with the rest of the participants as the relationships between the nodes clearly indicate no specific strength of connections. It can also be clearly observed that whilst the majority of the participants cluster together, three pairs of participants are lying outside of the central network. This means that the participants were chatting privately amongst themselves.

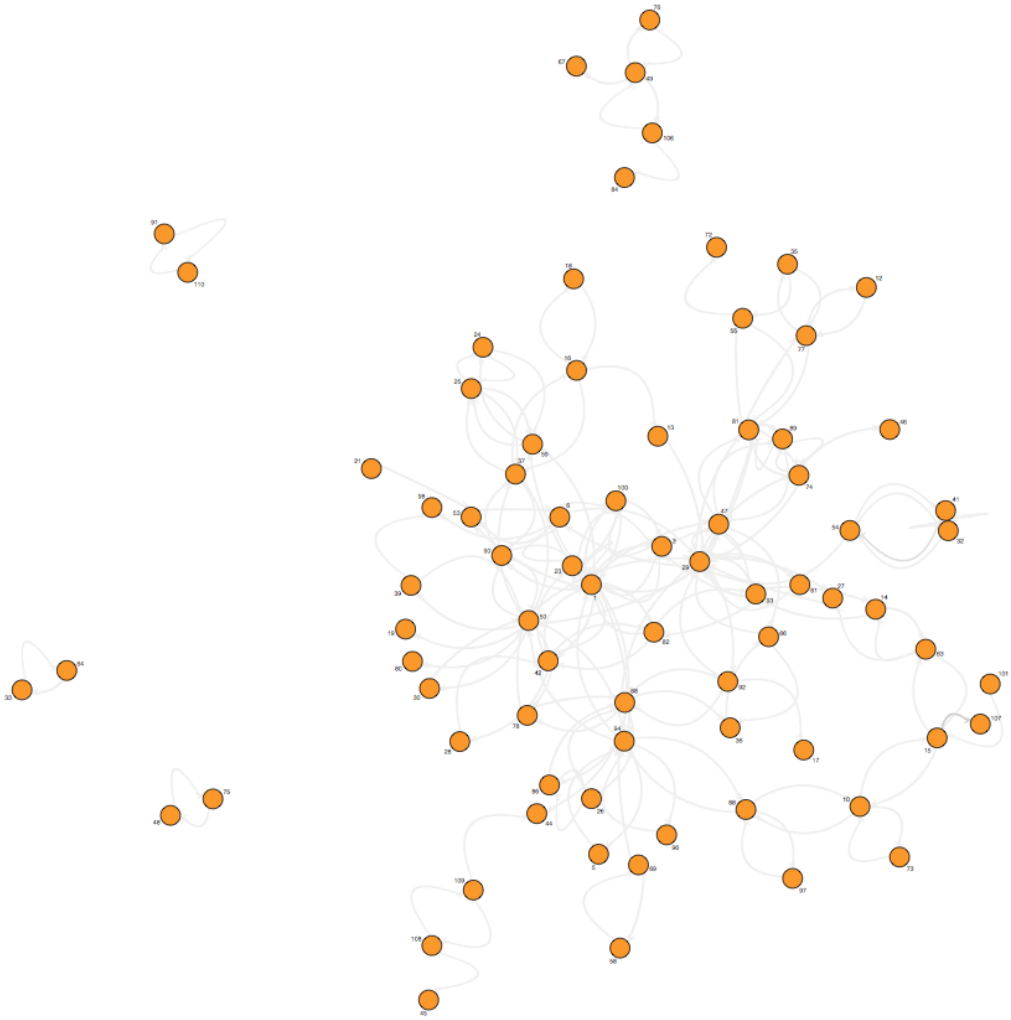

Figure 49 - A social network analysis graph using RStudio for private text chats between participants during week 2 in October 2012

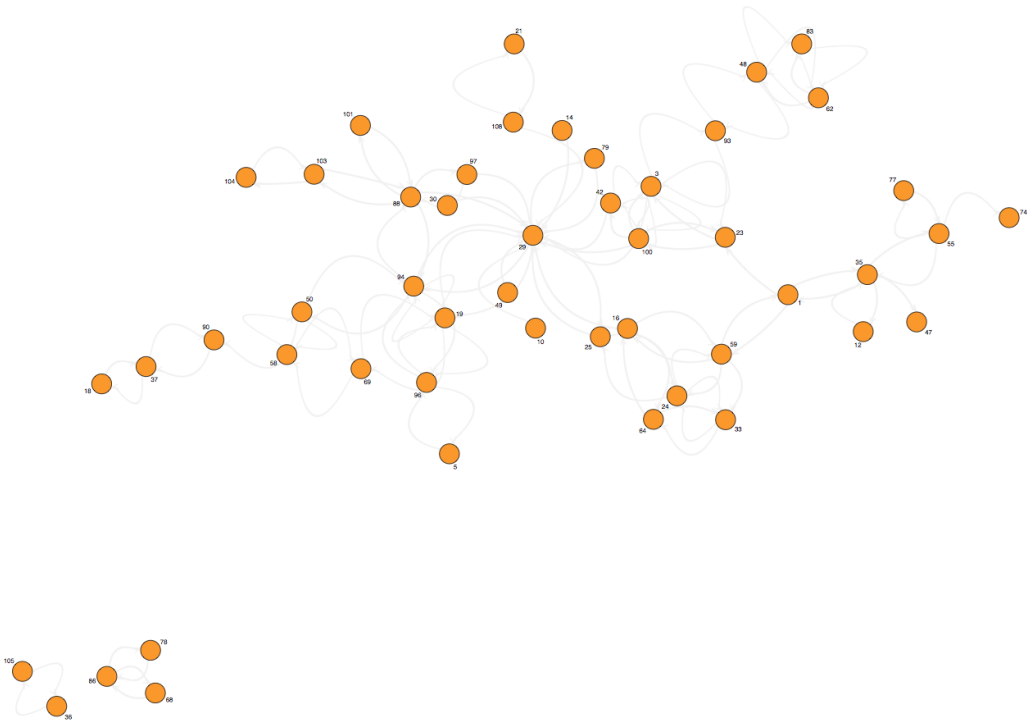

Figure 50 - A social network analysis graph using RStudio for private text chats between participants during week 3 in October 2012

During the third week the network shows a clearer dispersion of the nodes and a return of the centrality of node with ID:29 (Figure 53). This could be due to the fact that this week precedes the week where the students are working on their online tasks to present during the following week's seminar activity. However, five nodes still lie at the periphery of the network. This graph also shows a clearer demarcation of the communities being formed during the third week of PreVieW.

The graph of the private text chat networks for week 4 (Figure 54) shows node clusters in the central area. Community formation is more pronounced in this week. This is the week where the participants are presenting their work in the VW during a public information seminar. The probability is that these small communities were formed as the larger groups broke into smaller divisions, with the scope of discussing more individual roles for the completion of the tasks.

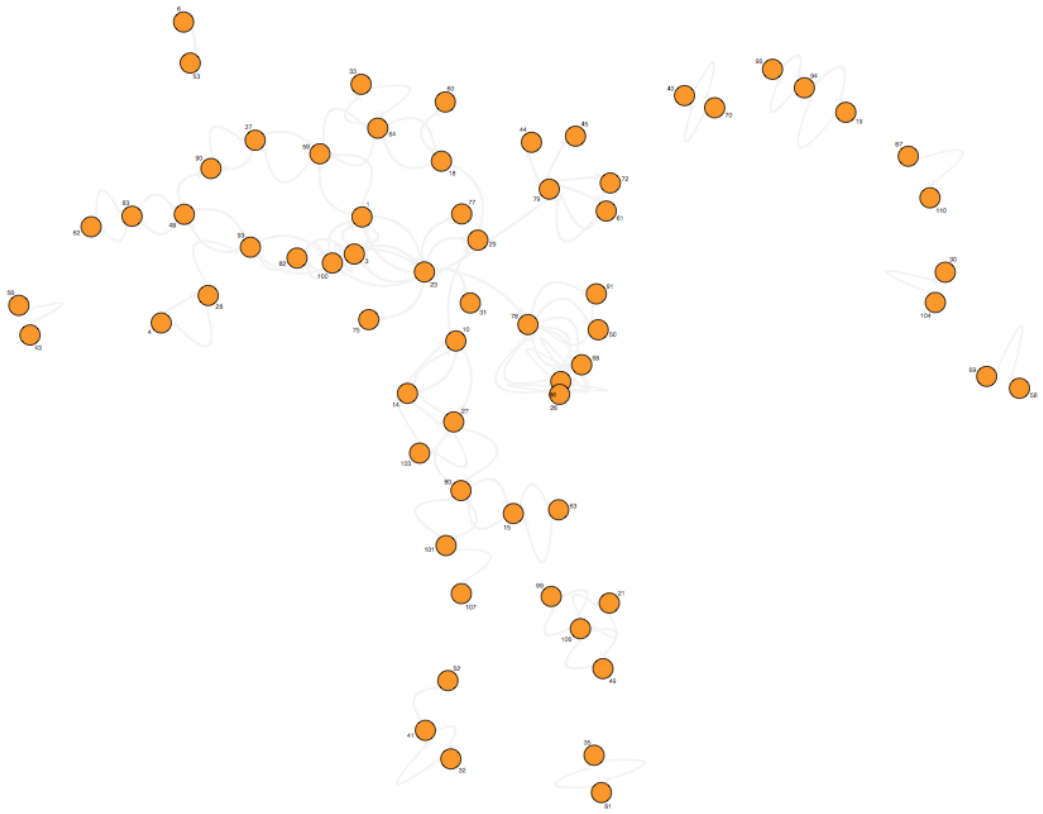

Figure 51 - A social network analysis graph using RStudio for private text chats between participants during week 4 in October 2012

Figures 48-54 give a visual indication of the networks developed in the VW, through an analysis of the private text-chat interactions amongst participants inside the VW for the period between October and December 2012.

APPENDIX 8: STATISTICAL REPRESENTATIONS OF TEXT-BASED INTERACTIONS

The BIC or Bayesian Information Criterion is commonly used when the conventional p-values are problematic. This may arise from scenarios where random associations may not always be detected or where the size of the sample data is considerably large. In PreVieW, data logs were collected about the participants' movements inside the VW throughout the 13 weeks. This generated thousands of interactions and a considerably large amount of data. The table above shows the participants' degree of interactions during the month of October 2012. This was the month that registered the greatest number of interactions through the established connections. The social network analytics collected from the VW show an overall tendency by the participants to communicate using group text-based messaging. This is especially evident during pre-set and organised information session meetings. However, out of all the participants, only 17% of the participants displayed a high degree of text-based interaction with the rest of the participants. The BIC determined that two main clusters of participants emerged (Figure 57). The two clusters are determined by the frequency of interactions.

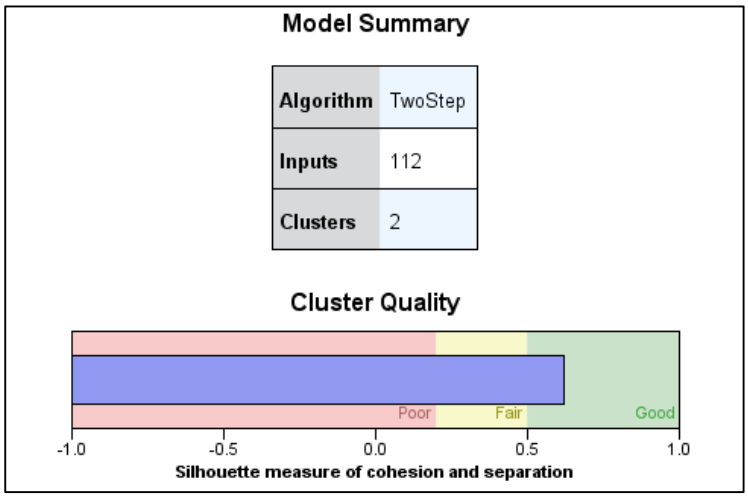

Figure 52 - BIC Model Summary for the chosen clusters

Table 29 - Bayesian Information Criterion (BIC) for the clusters of interactions inside the VW

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change	Ratio of BIC Changes	Ratio of Distance Measures
1	9539.6			
2	7466.9	-2072.6	1.000	3.340
3	7585.6	118.7	-.057	1.674
4	8081.1	495.5	-.239	1.218
5	8676.8	595.7	-.287	1.446
6	9414.1	737.3	-.356	1.378
7	10238.6	824.5	-.398	1.085
8	11081.1	842.5	-.406	1.011
9	11926.0	844.9	-.408	1.154
10	12798.9	872.9	-.421	1.189
11	13700.7	901.9	-.435	1.135
12	14620.8	920.1	-.444	1.205
13	15563.8	943.0	-.455	1.015
14	16508.4	944.6	-.456	1.094
15	17462.5	954.1	-.460	1.022

The table below shows the cross reference of each participants' ID as they receive messages sent from participants found in cluster 1 and cluster 2. Cluster 1 represents participants who have sent and received the greatest number of text messages, whilst cluster 2 represents the participants who have sent the least number of text messages in the VW experience.

Table 30 - Table cross referencing participant IDs with reference to participants in the two chosen clusters

Participant receiving text chat message	Participants in Cluster 1 sending text chat message		Participants in Cluster 2 sending text chat message	
	Mean	Std. Deviation	Mean	Std. Deviation
ID.1	27.65	17.54	6.05	6.97
ID.2	6.12	6.08	1.10	2.58
ID.3	23.35	17.08	7.04	16.06
ID.4	8.82	10.23	1.52	3.73
ID.5	17.06	11.71	4.11	7.83
ID.6	21.59	22.69	2.81	3.17
ID.7	10.94	4.94	2.11	2.46
ID.8	15.53	9.52	2.49	2.81
ID.9	10.24	11.47	1.85	2.54
ID.10	27.82	17.64	4.77	4.55
ID.11	17.24	15.53	4.07	7.48
ID.12	32.29	34.63	4.76	6.97

ID.13	17.12	12.08	2.28	2.76
ID.14	24.88	10.82	4.11	4.26
ID.15	21.18	9.95	4.05	4.61
ID.16	13.18	14.07	3.67	6.33
ID.17	22.41	9.98	3.77	3.77
ID.18	31.71	20.47	6.22	6.52
ID.19	20.24	21.53	4.32	6.87
ID.20	21.24	19.14	6.22	9.67
ID.21	27.65	15.72	6.78	10.01
ID.22	11.06	11.87	2.45	6.47
ID.23	27.76	24.84	13.14	65.55
ID.24	24.82	8.51	4.62	4.88
ID.25	22.76	13.06	4.06	4.36
ID.26	31.94	33.17	6.19	16.98
ID.27	23.24	12.53	5.41	5.94
ID.28	14.29	7.56	3.21	3.75
ID.29	33.65	18.44	10.06	11.10
ID.30	17.88	17.08	7.27	14.88
ID.31	12.47	7.12	2.50	2.53
ID.32	16.71	10.07	2.23	2.45
ID.33	19.59	8.68	4.50	4.93
ID.34	11.29	4.81	3.15	4.50
ID.35	27.06	18.86	4.63	5.90
ID.36	22.76	29.56	6.81	15.22
ID.37	25.06	9.45	4.31	4.22
ID.38	13.76	11.97	2.38	3.41
ID.39	14.41	6.92	3.09	4.45
ID.40	6.76	7.93	1.41	3.48
ID.41	17.59	9.73	3.12	3.55
ID.42	17.12	14.43	5.33	16.71
ID.43	33.59	27.32	6.30	6.94
ID.44	22.47	7.86	4.11	4.21
ID.45	30.24	12.37	5.46	5.98
ID.46	11.12	5.29	2.68	2.91
ID.47	19.18	12.52	4.17	5.76
ID.48	26.59	14.24	5.64	6.54
ID.49	23.41	12.53	5.88	10.16
ID.50	25.41	15.14	5.48	5.62
ID.51	20.41	9.43	3.59	3.26
ID.52	12.06	6.81	3.01	3.30
ID.53	24.47	25.70	5.28	5.21
ID.54	22.00	9.23	3.48	3.25
ID.55	15.82	10.85	3.16	4.94
ID.56	13.24	10.37	2.41	3.93
ID.57	7.82	4.49	2.20	2.36
ID.58	2.47	2.70	1.10	1.82
ID.59	34.00	36.95	6.69	7.77

ID.60	7.53	8.07	1.50	3.73
ID.61	23.65	8.56	3.70	3.62
ID.62	29.88	24.34	5.99	6.22
ID.63	24.65	11.78	4.16	3.90
ID.64	23.76	11.89	5.17	5.64
ID.65	11.29	28.79	1.24	1.94
ID.66	9.00	8.94	2.90	4.64
ID.67	15.24	8.08	2.72	3.08
ID.68	27.76	22.83	8.00	20.08
ID.69	11.00	4.81	2.36	2.66
ID.70	10.35	8.67	2.31	3.66
ID.71	16.88	8.40	3.78	4.31
ID.72	28.18	37.51	4.39	5.51
ID.73	19.12	10.28	3.13	3.07
ID.74	25.35	17.19	4.23	5.73
ID.75	27.94	10.47	4.72	4.54
ID.76	21.76	15.35	4.84	7.83
ID.77	24.12	28.49	3.64	4.87
ID.78	27.18	29.18	10.61	25.18
ID.79	21.18	52.86	2.87	4.16
ID.80	24.06	14.30	6.04	6.17
ID.81	24.00	14.84	5.15	7.25
ID.82	21.12	9.41	6.82	20.52
ID.83	19.71	7.61	4.27	4.44
ID.84	13.35	4.47	2.66	2.82
ID.85	5.24	3.91	1.79	2.71
ID.86	21.41	23.87	6.57	21.63
ID.87	10.12	5.89	2.57	2.81
ID.88	23.12	10.19	4.80	4.52
ID.89	21.35	18.77	3.63	6.33
ID.90	18.29	13.96	4.35	6.09
ID.91	16.47	27.26	6.13	21.12
ID.92	20.65	8.55	4.30	4.45
ID.93	32.59	25.01	12.32	50.24
ID.94	22.41	12.48	5.50	7.60
ID.95	11.71	14.57	4.36	8.99
ID.96	20.35	10.69	4.90	7.85
ID.97	12.76	6.64	3.05	2.93
ID.98	14.94	8.47	2.81	3.18
ID.99	20.59	14.87	5.05	9.63
ID.100	30.76	17.64	10.59	34.70
ID.101	18.41	8.11	3.28	3.92
ID.102	18.76	16.41	4.24	4.08
ID.103	15.65	8.25	3.39	3.24
ID.104	17.82	11.00	4.29	4.40
ID.105	15.47	28.76	5.24	14.35
ID.106	23.06	20.16	4.61	9.18

ID.107	18.88	10.22	2.98	3.96
ID.108	19.88	14.66	5.78	9.52
ID.109	28.47	33.28	3.91	3.51
ID.110	15.59	8.94	2.87	2.85
ID.111	14.88	16.35	4.03	5.99

APPENDIX 9: INTERVIEW VALIDITY CHECKLIST

This interview checklist has been developed, adopted and adapted from Tong, Sainsbury, & Craig (2007).

Voluntary Participant in Group Interview	☐
Participant has experience in PreVieW	☐
Interviewer is participant in PreVieW	☐
Interviewer experience is the same for all interviews	☐
Prior relationship between participant and interviewer	☐
Participant selection based on different field of studies	☐
Method of approach for recruitment is over email	☐
Pilot testing of prompts for interviews	☐
Audio device used to record interviews	☐
Duration of interviews of 1 hour	☐
nVivo software used for the coding of data	☐

APPENDIX 10: SAMPLING OF INTERVIEW PARTICIPANTS

The table below (Table 32) indicates the number of group text-based interactions of the participants invited to join the group interviews for the months of October, November and December 2012.

Table 31 - Group text-based interactions for interviewees

Participant ID	Number of group text-based Interactions		
	October 2012	November 2012	December 2012
1	290	114	38
3	2281	335	170
6	268	445	0
8	281	291	n/a
14	593	314	1474
17	41	161	179
18	1277	586	792
22	709	149	0
23	1241	95	244
25	465	177	679
37	24	59	0
41	370	866	543
43	824	422	643
44	910	73	33
45	1012	523	444
56	2013	386	0
64	765	163	456
78	2998	727	406
79	2069	666	n/a
83	155	33	367
92	41	0	n/a
93	486	538	165
98	277	18	93
106	555	633	n/a
111	948	0	178

APPENDIX 11: PRE- POST EXPERIENCE SURVEY

PRE- EXPERIENCE INSTRUMENT

Section A: Technology Acceptance

Perceived Usefulness of Internet Applications:

1. I find that the Internet can be very useful for my studies
2. I believe that when I finish my studies I will still find the need to use the Internet in my teaching
3. I only use the Internet for Social Networking
4. I think that using the Internet is a waste of time

Perceived Ease of Use:

5. I find the Internet easy to use
6. I can find solutions to knowledge-related problems using the Internet
7. Whenever I come across something which I do not know, I browse the Internet to find the solution

Attitude toward Using the Internet:

8. Using the Internet is very boring
9. I communicate with people mostly using the Internet
10. I think the Internet should be used only to chat, play games and shop online
11. I think that using the Internet these days is very important
12. I think that people who do not use the Internet today may be at a disadvantage with the rest

Behavioural Intention to use the Internet:

13. Using the Internet is not as easy as it sounds

14. I do not have the time to use the Internet

Perceived Complexity using the Internet:

15. Using the Internet is not as easy as it sounds

Experience:

16. I have been using the Internet for _____ years

Voluntariness in Using the Internet:

17. I use the Internet only because I am forced to do so

POST- EXPERIENCE INSTRUMENT

Technology Acceptance

Perceived Usefulness of Internet Applications:

1. Using the Internet can enable me to accomplish tasks more quickly
2. Using the Internet can improve my performance
3. Using the Internet can make it easier to do my tasks
4. Using the Internet in my job/school can increase my productivity
5. Using the Internet can enhance my effectiveness
6. I find the Internet useful in my job/school

Perceived Ease of Use:

7. Learning to use the Internet is easy for me
8. I find it easy to get what I need from the Internet
9. My interaction with the Internet is clear and understandable
10. I find the Internet to be flexible to interact with
11. It is easy for me to become skilful at using the Internet
12. I find the Internet easy to use

Attitude toward Using the Internet:

13. I have fun interacting with the Internet
14. Using the Web provides me with a lot of enjoyment
15. I enjoy using the Web
16. Using the Web bores me

Behavioural Intention to use the Internet:

17. I always try to use the Internet to do a task whenever it has a feature to help me perform it
18. I always try to use the Internet in as many cases/occasions as possible
19. I plan to use the Internet in the future
20. I expect my use of the World Wide Web to continue in the future

Perceived Complexity using the Internet:

21. Using the Internet can take up much of my time when performing many tasks
22. When I use the Internet, I find it difficult to integrate the results into my existing work
23. Using the Internet exposes me to the vulnerability of computer breakdowns and loss of data

Experience:

24. I have a great deal of experience using the Internet
25. Number of years using the Internet

Voluntariness in Using the Internet:

26. Using the Internet is voluntary as far as work/school is concerned
27. I am not required to use the Internet for work/school
28. While the Internet enhances effectiveness in completing tasks, it is not required that I use it

APPENDIX 12: EXCERPTS FROM QUALITATIVE DATA

A series of small group semi-structured interviews were conducted with 28 participants.

The themes emerging from these interviews are a direct result from the transcripts of the group interviews. The following are some of the excerpts of those transcripts.

RQ 3: PARTICIPANT REFLECTIONS

VW Connections

Establishing Connections

In relation to technical, logistical and organisational issues the participants revealed that:

- I believe it was the first world, the one where you go inside a corridor which then leads to an auditorium – I found a problem because if you don't log in much before the others, the corridor gets jammed with people and then you don't hear what's going on in the auditorium. So it's a problem with the layout (ID.37);
- There are small teething problems which have to be sorted out like the connection was the major – it was taking 10 minutes to log in (ID.78);
- It's not that easy to type especially if you are sharing a bulk of information or paragraphs. And if someone else types in the meantime, you would have to scroll to the bottom to try and understand. You can't for example lock, read what you have to read and then you can unlock and continue. Also I do know how to experiment and use videos and things which I can use in lessons, but there were many people who wouldn't for example know how to do a video in movie maker, or how to build certain resources or use the interactive whiteboard, there are people who need that certain push. And that was missing in the course (ID.93);

- The advantage that you could log in whenever – because we were a large group, we couldn't log in – especially when we had large group meetings. That bothered me a bit (ID.37);
- I don't know if it makes much difference but in the third one (VW) I didn't have any problem. In the second one I had problems with viewing presentations. If they would have additional links where we would be able to download them it would be better. I never encountered similar problems in the other worlds, but in that world they would always get stuck. I don't know why. For example, when you used to tell us we'd be having a presentation on a certain topic. You would let us choose to do whatever we wanted for it. There were those who would feel lost in it (ID.93);
- I found a problem with time and logistics. For example, during that time my children go to bed, and I wouldn't be able to help my husband with that. So then I would feel a bit guilty. Because this course is supposed to be full time but we don't have lectures in the morning and all seem to be in the evening. So it was not just about you. If they were morning sessions it would have been better for me (ID.3);
- And another problem which I found was that doing the presentation when you log in, the "doll" would launch inside a corridor, and if there are a lot of "people" there you won't be able to pass through. So if you need to do a presentation and you get disconnected, there is no way you can login again, and move towards the stage because the passage is blocked (ID.43);
- It seemed like there was a limit to how many could log in at the same time (ID.1).
- However, when I logged into the world and there were few people or I would be on my own, it would not disconnect. Possibly that heavy load of people might have affected, and if the computer is a bit slow – you have to forget about connection. My old laptop couldn't support the world so I had to use the netbook (ID.78);
- As we went along, I was progressing but there were obstacles which I felt were difficult. For example, if we could have met every so often, maybe just twice, as a whole group and you might have explained some stuff. Face-to-face is different. And then we'd go and apply them online (ID.98);

- My lights went out at home and we had a meeting in like half an hour and I went to a friend's house to listen to the talk from there. It was either there or I had to miss it. It wasn't something I could really control (ID.56);
- Yes we found it more challenging – we were asking each other – there were people who understood one end, the others understood another end – so we were a bit lost in the world (ID.41);

The connection at the content level included the course modality designed around the learning by exploration model. In this type of model participants were expected to build their own learning experiences, and to discover niches in their learning according to their individual needs. The challenges at this level were identified in terms of the lack of experience with such a model throughout their formation years. Participants frequently mentioned the consumption of the content available directly from the VW platform. However, few (n<3) student participants displayed enough confidence that would prompt them to contribute to the VW content, without being explicitly told to do so.

Identity

- Even that thing that you are trying to walk inside but you cannot because all the avatars are blocking the space. Trying to tell the others to move and nobody would move [laughs] (ID.92);
- For example, from what I saw in the world, there would be a lot of people whose names I recognise but I don't know who they are. The study-unit was not just about getting to know who is there. For example, only today did I realise this person's name is xxx. I see her and I don't know her name. So it's those types of sessions (ID.44);
- The fact that you could go around, click on the links, was better than just having a website (ID.45);

VW Reactions

- I absolutely see great advantages in using that. First of all you're there and at the same time you can continue the rest of your life. Even the fact that at certain times you get to university and it takes you an hour just to park. I mean

if you're at home, just click on your computer and you're working. There are big advantages there of course (ID.37);

- Yes – whilst for the other worlds I was saying that if I read a bit I would use them for my classes, etc. So the topic had an effect. The last world's topics could be applied so they were quite interesting (ID.78);
- For example, there was a video which interested me – don't know if I shared it with the others, but it was about using WII remote from TED talks. For example, I had never heard of TED talks, until I logged in the virtual world. So you can use it, and connect it with a projector, and using it, you can, even if you do not have an Interactive Whiteboard, you can use the WII remote to create your own Interactive Whiteboard. I didn't know this before. For example, that was one of the videos which I saved to be able to use it later on. And like it, there were other videos (ID.93);
- Even about gaming – because I, for example, did my paper on gaming in education. You start seeing possibilities that before I didn't even think about. It makes you think. These projects we had; they made us think. I think this is something we definitely got from this (ID.43);
- Rather than how to use technology – because even the articles were quite theoretical – but I sort of became more open-minded to technology. Before I used to say – for example, before I came to this course I used to say – but this Interactive Whiteboard, didn't we learn without it? Didn't we learn well? But now I am saying, with it, a lesson – for example, in science- before we used to draw the atoms on the board, now you can view the animation – so it is facilitating and helping visually especially those who are not verbally-oriented. So I am more open to technology after this course (ID.78);
- Yes you can do your own research and then you can say "Look I can use this or that" – not just like other study-units that tell you what you have to learn (ID.8);
- For both teaching practice one and teaching practice two, I made a website for the kids, so that everything I use in class is uploaded. I gave them extra material so that at any time and whenever they want they can access it. I tried to maintain the same concept of the virtual world (ID.79);
- I really liked the fact that you could log in whenever you wanted. I really liked that. And from there I got the idea of setting up the website for my students. I

really like the fact that I can log in at any time, take whatever I want and then I keep it. So even the fact that I got the website idea (ID.78);

- It was very efficient because if someone missed a talk he could go back. Many of us work so if the talk time coincided with the work then you could easily go back and refer to it. Even the links, the blog, links on YouTube and so on. I think that it was good that you could access them (ID.1);

VW Reactions - Course Modality

- But then when I went inside the world for the first time and listened to the podcasts about it then I started understanding a bit more. For example, in my case I used to log in and listen to all the podcasts and visit the links (ID.45);
- Maybe the 'dropbox' in the world, can be revisited. Maybe instead of sharing the desktop we could have other places where to display our work during the presentations (ID.23);
- During presentations – you used to share the desktop. Sometimes we would not be able to see clearly so maybe we could have other means of displaying their work. I really enjoyed it during this study-unit and I would look forward to other such study-units (ID.64);
- But then the PDFs with the tasks helped a lot, for example, I could understand, for example, when she was talking about group discussion, this was what she was referring to. Even the fact that you would answer our emails immediately or you would be in-world and we could contact you immediately (ID.8);
- For example, when you used to tell us we'd be having a presentation on a certain topic. You would let us choose to do whatever we wanted for it. There were those who would feel lost in it. There is the added fact that there wasn't a set curriculum. There were themes (ID.18);
- Yes you can do your own research and then you can say "Look I can use this or that" – not just like other study-units that tell you what you have to learn (ID.25);
- Something else which I liked was that many other lecturers would give you a set of readings – the fact that you can actually watch a video was a breath of fresh air. It's not just about reading (ID.79);
- I think that I would tell him that there is material which is continuously being updated and which he can access whenever wherever (ID.22);

- I would tell that person that this is a unit which is being updated not just by lecturers but also by students. I remember when all the work of the students was put up online on posters. So I think the unit was that it wasn't just us receiving something, but we actually did the unit (ID.14);
- And it's not learning something like – "Today we shall learn about this" and you would start explaining it (ID.3);
- And the fact that we kept on seeing different methods throughout, of how to access material, and to revise material (ID.1);

The connection with other avatars was established through various communication channels, as visually displayed in the social network graphs created from the learning analytics collated from the VW platform. Text-based group communication, by far generated the greatest number of logs, indicating the most preferred form of communication chosen by the student participants. The formation of groups during the communication sessions can be identified. However, these groups are not clearly demarcated giving the indication that many people were communicating randomly, with the aim of getting to know people who were doing their same program of studies. Participants remarked that they got to know more people in the VW than they could do during the face-to-face teaching as most often they were split into groups depending on their subject area and field of studies.

VW Reactions - Course Outcomes

The course outcomes were determined by the participants' reported level of self-efficacy and self-belief following their PreVieW experience. Participants reported an initial sense of fear of the unknown as they were immersed in an experience which was new to them. However, the interviewees also indicated that throughout the 13-week period they managed to achieve more confidence in their abilities, and to acquire an increased know-how about technology that is applied to practice.

VW Reactions - Course Outcomes – Self-efficacy

- For example, we had an activity where we had a talk and then we had to split up inside the virtual world in groups. I think that over there we had a lot of problems (ID.6);

- So that was good, actually having a presentation and listening to others, because there was always something new. That I liked, the idea of presentations (ID.79);
- I agree with the concept of the Virtual World – because I think we have to move forward. So that instead of having like we used to have, a normal classroom, we'd have something innovative (ID.83);
- We had a problem with the connection, with the speed, but the idea is ideal. You can attend the lecture from wherever you are, from the comfort of your home (ID.106);
- I liked the idea of the area, because even if I covered computational thinking, I still learned more than I knew before (ID.18);
- It would have been more difficult (with MOODLE) because of communication but other than that it wouldn't have made much difference. It was nice to log in and chat with other people to share ideas. It is very difficult to do this using a website (ID.93);
- But over there (MOODLE) there is only written content. So for example, I find it difficult to express myself – especially if (since I am a Science student) this has nothing to do with science – I prefer to talk so that if I have a problem – on Moodle I cannot. At least over there (VW) I had the advantage that I could express myself orally (ID.78);
- For example, there was a video which interested me – don't know if I shared it with the others, but it was about using WII remote from TED talks. For example, I had never heard of TED talks, until I logged in the virtual world (ID.93);
- We never had anything like it and personally I liked it (ID.106);
- There is the added fact that there wasn't a set curriculum. There were themes (ID.41);
- Yes you can do your own research and then you can say "Look I can use this or that" – not just like other study units that tell you what you have to learn (ID.8);
- The fact that you can have access to it, whenever you wanted, even at 3am – you would log in (ID.1);
- I really liked the fact that you could log in whenever you wanted. I really liked that. And from there I got the idea of setting up the website for my

students. I really like the fact that I can log in at any time, take whatever I want and then I keep it. So even the fact that I got the website idea (ID.78);

- At first, you know as I told you – I was a bit wary but then after the orientation, I thought "Ah ok – so you can do this, this and this and that is perfect." So then it was great. If all the lectures had to be like that – ok, not all lectures can be done this way but it is so time efficient – it is so much more 'comfortable' for those who teach and for those who are learning – you can access all the information whenever he wants, wherever he wants at whatever time he wants (ID.17);
- Certain things are restricted on Moodle. For example, I am going to see pdf, document – all in text on Moodle. The fact that you can move inside a room, watch previews, I really like previews "Ah yes I saw this, I saw that – oh look something interesting. Oh look I didn't see that image at the start" And I remember that what was really interesting, was that you could share your desktop (ID.45);
- And it would be the same thing you would see during the lecture. In our world we had so much different material. If we are talking about mobiles, you would have that website, that video. In Moodle, they would upload the PowerPoint we'd have already seen to see the same notes. This was something different. If I am watching the video it's because I want to watch it. I am learning without even knowing. I think that is the basic difference (ID.83);
- So you feel like saying – "Come on this study-unit was good. Why didn't you feel good?" For me it was brilliant (ID.17);
- I would like to find a place where there are many different resources (ID.106);
- I think I prefer it social than a game (ID.98);
- So I liked the idea of it being social (ID.18);

VW Reactions - Course Outcomes – Personal needs

- You know, before I used to think that teaching was walk into the class, teach, but it opened my eyes on how I can use other things. Ok I am not going to go to class to teach IT but it's a first step. In the beginning I used to think it's important but I am probably never going to use them and honestly, I was an English teacher for a couple of years and I don't think I ever had to use,

besides a simple video, I've never actually had to use IT, but nowadays it's given me an opportunity to open up (ID.111);

- So you can use it, and connect it with a projector, and using it, you can, even if you do not have an Interactive Whiteboard, you can use the WII remote to create your own Interactive Whiteboard. I didn't know this before. For example that was one of the videos which I saved to be able to use it later on. And like it there were other videos (ID.93);
- We are all the time being told that students are not as they used to be. Lessons need to be interactive as much as possible. And they should be fun. And then we come here, especially in some courses – like sociology, philosophy – you come here, you read papers that date back to trade schools. You wouldn't understand anything. They're teacher-centred because all you listen to is the lecturer. The good thing about the applied [study-unit] and this is that it is literally student-centred. And if we want to teach in this way, it is a good thing to get used to this and we learn in this way ourselves. So for some courses [study-units] I agree that we need to change and we move towards this – gradually (ID.3);
- I am finding it quite satisfactory. I have a bit of a phobia?? That I appear on video to the whole world. But I usually find what I require. During lessons, I prepare videos, and they (the students) suggest some videos. And I find them there and then. I would know about them before, but I find it there and then and they can listen to it then (ID.43);
- No it doesn't bother me. But the students feel that we are not prepared for it. For example, with us, with young student teachers they feel much more at ease because "they are able to use the Interactive…, and they do the nice things on the Interactive and they make us get up to participate… what do the others do?" Not to criticise but there is no preparation there. So let me say something – I am seeing the iPad here. Let's talk about the tablets issue – ok. We're going to have tablets. But you need to give the people who will be using these things the opportunity to explore by himself what he can do. Don't come lecture me about the things you can do with the iPad. Maybe you can tell me which books to download. Fine, but give it to me and let me explore. Speaking for myself, I buy a gadget, I don't even look at the instruction book. I prefer to explore. That is the way we learned how to use the computer. Nobody came to

tell us how to do it. We explored it and today we know it. My mother asks me – but how do you remember these things – it's because I learned it by myself. During ECDL I learned Microsoft Access. I don't use it. I just learned it off by heart for the ECDL, got the exam, and now I don't know how to use it (ID.64);

- I think it's about the system as well. There are schools where if you don't give the students notes, you're not a good teacher. There are classes, who are more happy-go-lucky and don't care about whether they get notes or not. I think it's the whole system, because there are those who are too academically oriented and they want a whole bunch of papers to put in the file and feel they are learning because they have a thick file. And then I think – most of the learning…(ID.78);
- It has to be a mixture. Because what are you going to do with all the papers? You need to work on them. I think it's more demotivating when you know you have to go through all the papers (ID.106);
- Because if you had to show it to the students. We worked on a website – so then your students can see it. Something simple which I used during TP was just a remote and there was already a lot of "Awe" about it. Let alone the video etc. (ID.17);

The comments above indicate that the participants are aware of the different practices of teaching and learning. Their comments also show a degree of perplexity with the expectations from schools and different stakeholders, but it also shows a degree of perplexity in their perceived unpreparedness towards using technology practices.

VW Adjustments

Self- Perceptions

During the interviews the participants also expressed their self-doubt and lack of self-belief through their perceptions about how age and subject area affected their perceived competency in the application and use of technology.

- I think it depends on the subject – for example, those of us from the Computing subject, have the computer that in itself … for example, Maths is much more difficult as a subject to keep students motivated. For us, the computer helps you (ID.64);
- My mobile up until some time ago, wasn't a smart phone. I found using the smart phone quite difficult – so you can note how bad I am at these things – but this unit, at first – I study geography (ID.93);
- I thought I was a bit knowledgeable about computers and stuff and now I realise that I am not so knowledgeable at all (ID.98);
- I never had – I know how to use the computer but I never had to work using the computer (ID.111);
- I think you'd find both types. I consider myself a technological person. Everything can be online. I still need the paper though. I prefer to study on paper. But I am not the type to be spoon-fed "Cause we don't have notes – we don't have notes …" But you always find the type who would want everything spelled out otherwise he'd feel he's not learning (ID.78);
- It's been ages since I stopped from school and studying and I just started back now, this year. When I started out – this 'learning…" all virtual and all that … I just couldn't get to grips with it. And then, …(ID.3);
- Maybe if I managed from a scale 1-10 to get to scale 3 for me it was a really good achievement. I never expected to get to scale 10 for example. But I always learnt something new (ID.56);
- In the beginning I used to think it's important but I am probably never going to use them and honestly I was an English teacher for a couple of years and I don't think I ever had to use, besides a simple video, I've never actually had to use IT, but nowadays it's given me an opportunity to open up. Anything that can make the class more interesting, and help make more successful students – why not use it? Before I didn't know what was there to use. Now I have a basic idea (ID.111);
- I have become more confident after Teaching Practice. Because it's fine to search and look for information, but until you have a hands-on. I am a science student, so for me everything has to be hands-on. For me to see a video is not enough. For example, the interactive whiteboard, I hear someone say drag and

drop, I go to look for info on YouTube, and I find it. But I need to try it out. It's not enough to see it on YouTube (ID.78);

- There are many who as soon as you mention computer they get scared (ID.14);
- And I am not very computer savvy – not good with these things so I couldn't really understand how to go into the world and post ideas and see videos online. I was a bit confused. Since I am not good at computers, I didn't know how to move around and what I could really do with it. So even though I should try and experiment, then I didn't know (ID.56);

In the excerpts above there are references to age, subject matter and their self-belief in handling technology. The participants justify their lack of confidence in the area by making reference to their abilities according to their subject area, or their perception of learning.

Practice-driven approach

- In the beginning I used to think it's important but I am probably never going to use them and honestly, I was an English teacher for a couple of years and I don't think I ever had to use, besides a simple video, I've never actually had to use IT, but nowadays it's given me an opportunity to open up. Anything that can make the class more interesting, and help make more successful students - why not use it? Before I didn't know what was there to use. Now I have a basic idea (ID.111);
- Rather than how to use technology, because even the articles were quite theoretical, but I sort of became more open-minded about technology. Before I used to say, for example, before I came to this course I used to say but this Interactive Whiteboard, didn't we learn without it? Didn't we learn well? But now I am saying, with it, a lesson for example in science, before we used to draw the atoms on the board, now you can view the animation so it is facilitating and helping visually, especially those who are not verbally oriented. So I am more open to technology after this course. (ID.78);
- I would say that I didn't feel like I was learning. It was something which I was already aware of and it was made clearer, or something which I could discover along the way but you wouldn't be aware of the discovery. (ID.3);

- And it would be the same thing you would see during the lecture. In our world we had so much different material. If we are talking about mobiles, you would have that website, that video. In Moodle, they would upload the PowerPoint we'd have already seen to see the same notes. This was something different. If I am watching the video it's because I want to watch it. I am learning without even knowing. I think that is the basic difference. (ID.23);
- At first, you know, as I told you I was a bit wary but then after the orientation, I thought 'Ah ok so you can do this, this and this and that is perfect'. So then it was great. If all the lectures had to be like that ok, not all lectures can be done this way but it is so time efficient, it is so much more comfortable for those who teach and for those who are learning you can access all information whenever he wants, wherever he wants, at whatever time he wants. (ID.44);
- Compared to what I knew before, learning technologies are extremely vast. They can be anything from an interactive whiteboard to a virtual world, to games, to a video. This is all in the field of interactive technology. It's opposed to the imparting of information face-to-face, you do the exam and you're finished. When you're actually doing something, you internalise it more. (ID.6);
- For example, there was a video which interested me, don't know if I shared it with the others, but it was about using WII remote from TED talks. For example, I had never heard of TED talks, until I logged in the virtual world. So you can use it, and connect it with a projector, and using it, you can, even if you do not have an Interactive Whiteboard, you can use the WII remote to create your own Interactive Whiteboard. I didn't know this before. For example, that was one of the videos which I saved to be able to use it later on. And like it there were other videos (ID.93);
- For both teaching practice 1 and teaching practice 2, I did a website for the kids, so that everything I use in class is uploaded. I gave them extra material so that at any time and whenever they want they can access it. I tried to maintain the same concept of the virtual world (ID.79);
- I think there are things in the subconscious. For example, during teaching practice, you try, you know, not to do a lesson where the teacher speaks all the time. You try to include them and then you can create stuff with technology that the kids would be interested in and in the same way you would be

changing the way a lesson would be done. And at the end I think that is the way it should be done. Because the kids would be interested and participate, you would enjoy doing the lesson and there would be new resources that can reflect today's society (ID.1);

- It depends - why? Because much material found is in the English language. Obviously you would find other stuff in your language but it is more restricted. As we go along, they are increasing but there are some restrictions. However, once you find, for example, I found French games - it was interactive and they loved it. They learned transport just through it. I didn't even say a word. I just let them play a game on the interactive whiteboard, and it worked miracles. They would remember it. You wouldn't even believe how they would remember them. For example, I heard this as well in class 'Miss, do a game so that we can play and learn using a game'. You can find resources; obviously the more time passes the more resources you find. But yes, with some languages you might be more restricted (ID.17);
- I think it was during the last week and it was about Italian culture and modern art. It was an introduction. I did a PowerPoint presentation and I started by introducing 'What is Art?' I asked them 'what could we draw or paint on?' They would answer and we would go on from there. So I asked them 'what can we draw on?' On paper, etc. traditional means. But then I found pictures of the 3D street art so I asked them 'is this art or not'? Then I found stuff which is not conventional to which they would answer 'ah yes' but then I started to show them. Then I included a bit of culture, then I showed them a video of someone drawing with sand. And it really engaged them. And I asked them if that was art. And so we sort of came up with what art is doing, whether it is realistic, etc. You could see and you could feel that they enjoyed it and that they had learned. Because then throughout the lesson I was giving them words to work with like 'pennello' etc. so you could understand that they really enjoyed it (ID.83);
- The lesson I remember is what I have already described, the transport lesson. At first I had the problem with the Interactive Whiteboard but then somehow I did something with the cable and I connected. So the lesson wasn't planned like this; there was a lot of myself talking planned for that lesson. However, since it took a lot of time to set up the interactive whiteboard I decided to go

for the French games immediately. I told them that we would be doing a transport lesson. I split them in two groups and the game itself first teaches you some words. I told them to pay attention as then they would play games. Their first reaction was 'Games?' There was a lot of excited shouting in class. I showed them a simple transport method complete with article which is a huge headache to teach in French. They had a number of games including hangman, who's the right one. In thirty minutes they learned the transport system complete with article (ID.17);

Culture

- I think it's in our culture that we always keep back, so that may be why people would stay in the corridor (ID.37);
- I think it's part of our culture. There isn't the discipline – we had a speaker from Sweden. We know that Sweden are so much more disciplined than us (ID.93);
- This is something – we have to chase. It's our Maltese culture – the fact that it's a post graduate you still need to chase them (ID.64);
- It doesn't mean it's the right mentality, but it's the way we're used to. You study for the exams. We have that mentality. We do something and we get something in return – we do the exam and we get the mark. Slowly this needs to change but we have to remove this gradually (ID.1);
- I don't agree that you have to learn because someone is forcing you – far from it. But because the mentality is like that, we cannot just change like that. For example, for Science I always follow inquiry-based learning, because I like it. I cannot see myself not doing it that way. But if you don't give them an aim to do something, for example, last time, I gave them a case and they had to write a report – and they didn't want to – they were telling me – why should we do this? I had to award a grade for this to incentivise them (ID.93);
- Because we're used to that method (ID.41);
- I think that students from Languages will not be using it much (ID.17)
- It's all in the mentality (ID.22);
- Because if people start using it then everyone will use it. It's a matter of mentality (ID.23);

- I used to be on MIRC – I don't know if you remember it. We sort of shift. And then those people who play games (ID.78);
- There are people who do not like sharing (ID.83);
- I think it's more about I found something and I think it's useful. Why not share it? I didn't learn in this way. When I was doing an Engineering course, it wasn't the way I was taught. It was all about lecturing. So I still saw an improvement. I don't know how teaching was before but I saw that as very useful about how I should teach. I was already teaching before and I used to teach in a very traditional way, just as I was taught. So when I compare Dr XX and Dr YY's teaching and Ms ZZ's examples – I really learned how to teach (ID.3);
- For those people who are open to learning the experience is very positive I think (ID.106);
- I think that in the end everyone tries something new, even though they might make a big deal out of it (ID.14);
- I think you have to be ready for change – if you can accept the change – this is like when we switched from Hi5 to Facebook (ID.6);
- I think it's a lot about the habits acquired in the classroom. If learners get used to spoon-feeding it's what they would want. If you let them experiment, at the end they will learn. I think that that is the approach I was using. They were able to look for information and do stuff on their own. I think that sometimes we don't trust that they can somehow manage. Most probably they would manage better than we do (ID.3);
- However, overall the experience was really different. I didn't feel it belonged to University. It's like with everything. If I were to make a chocolate cake there will be those who will like it and those who will not, there are people who have been used to traditional note taking. I think they found it strange or maybe they would ask: Is this really a lecture? Am I taking enough information? (ID.43);
- These are things people are coming across whether they want to or not. But I am not the type to be spoon-fed "Cause we don't have notes – we don't have notes …" But you always find the type who would want everything spelled out otherwise he'd feel he's not learning (ID.1);

- Yes because it's also motivation for you. It's like a puzzle. So you have this piece but maybe for the exam you need another piece. It's not to say that during the lecture they might not give you the information but they can tell you that, for example, you can access it from somewhere. It's the fact that you need to do work, because if you find everything done for you what would you do then. You will just process the stuff, memorise them, go to the exam and that is all. It's not like you're thinking or something (ID.93);
- But now they have the Fronter[25] coming up. It's not the same thing but it's similar. When I was during TP, there was panic amongst the teachers because of that. Complaining about the laptops and how they will work and that they don't have battery power. We're living in an era which is technological. We cannot do anything about it but work. That's the way I understand it. For example, before there was the typewriter, then there was the computer, and there was the same transition. It had to be done or otherwise nobody would be where we are today (ID.41);
- Because they are comfortable (ID.98);
- Since they don't know how to use it or they give up – "What is this?" they don't know the advantages (ID.111);
- I think that was what we lacked. We have always been used to being told how to do stuff and to follow certain steps…to present this and so when something was different – you gave us the space to be more free but when we felt this space – we're so used to being closed in – I think that this is also something negative about schools – we're so used to being given notes and stuff rather than having them, as students, working – I think the mentality is changing but maybe we're the ones who are used too much to that kind of mentality. I think that when we're held tight, we would say we're too tight – but now that we could experiment – and learn our own ways, we still complained, so I suppose…(ID.79);

[25] Fronter refers to iLearn, the eLearning Platform (https://ilearn.edu.mt/) launched in 2012 for all the state schools in Malta as part of the Smart Learning Strategy 2008 Online: http://www.rcc.gov.pt/SiteCollectionDocuments/e-Gov-Malta.pdf [Last Accessed: April 2014]

RQ4: REAL WORLD BEHAVIOUR

- You know, before I used to think that teaching was walk into the class, teach, but it opened my eyes on how I can use other things. Ok I am not going to go to class to teach IT but it's a first step. Oh for sure, I used to teach English, like I said. Basically, what you taught yesterday you're teaching today, you're teaching tomorrow, but with IT it gives you so many ideas that you can use that you don't even think about until you see them – and makes the class so much more successful (ID.111);
- So you can use it, and connect it with a projector, and using it, you can, even if you do not have an Interactive Whiteboard, you can use the WII remote to create your own Interactive Whiteboard. I didn't know this before. For example, that was one of the videos which I saved to be able to use it later on. And like it there were other videos (ID.93);
- We are all the time being told, that students are not as they used to be. Lessons need to be interactive as much as possible. And they should be fun. And then we come here, especially in some courses – like sociology, philosophy – you come here, you read papers that date back to trade schools. You wouldn't understand anything. They're teacher-centred because all you listen to is the lecturer. The good thing about the applied [study-unit] and this is that it is literally student-centred. And if we want to teach in this way, it is a good thing to get used to this and we learn in this way ourselves. So for some courses [study-units] I agree that we need to change and we move towards this – gradually (ID.3);
- (I) Did you ever upload some yourself? [refers to YouTube videos]
  Personally no (ID.78)
  (I) Do you think you could do it or is it enough that you download others?
  I am finding it quite satisfactory. I have a bit of a phobia that I appear on video to the whole world. But I usually find what I require. During lessons, I prepare videos, and they (the students) suggest some videos. And I find them there and then. I would know about them before, but I find it there and then and they can listen to it then (ID.78);
- But I am still confused about whether I can use it in Maths, for example (ID.23);

- No it doesn't bother me. But the students feel that we are not prepared for it. For example, with us, with young student teachers they feel much more at ease because "they are able to use the Interactive…, and they do the nice things on the Interactive and they make us get up to participate… what do the others do?" Not to criticise but there is no preparation there. So let me say something – I am seeing the iPad here. Let's talk about the tablets issue – ok. We're going to have tablets. But you need to give the people who will be using these things the opportunity to explore by himself what he can do. Don't come lecture me about the things you can do with the iPad. Maybe you can tell me which books to download. Fine, but give it to me and let me explore. Speaking for myself, I buy a gadget, I don't even look at the instruction book. I prefer to explore. That is the way we learned how to use the computer. Nobody came to tell us how to do it. We explored it and today we know it. My mother asks me – but how do you remember these things – it's because I learned it by myself. During ECDL I learned Microsoft Access. I don't use it. I just learned it off by heart for the ECDL, got the exam, and now I don't know how to use it (ID.78);
- I think it's about the system as well. There are schools where if you don't give the students notes, you're not a good teacher. There are classes, who are more happy-go-lucky and don't care about whether they get notes or not. I think it's the whole system, because there are those who are too academically oriented and they want a whole bunch of papers to put in the file and feel they are learning because they have a thick file. And then I think – most of the learning… (ID.41);
- It has to be a mixture. Because what are you going to do with all the papers? You need to work on them. I think it's more demotivating when you know you have to go through all the papers (ID.64);
- But now they have the Fronter [refers to the eLearning platform implemented in government and state schools in Malta] coming up. It's not the same thing but it's similar. When I was during TP, there was panic amongst the teachers because of that. Complaining about the laptops and how they will work and that they don't have battery power. We're living in an era which is technological. We cannot do anything about it but work. That's the way I understand it. For example, before there was the typewriter, then there was the

computer, and there was the same transition. It had to be done or otherwise nobody would be where we are today (ID.41);

- Because if you had to show it to the students. We worked on a website – so then your students can see it. Something simple which I used during TP was just a remote and there was already a lot of "Awe" about it. Let alone the video etc. (ID.79);

Researcher Personal Log

- This to me is a very important strength of the course and what the course modality wishes to achieve. In my opinion, the relevance of the translation of the virtual world behaviour into real world behaviour is found in a gradual process as the student participants embark on this learning experience. This has also been shown to occur, albeit maybe in different circumstances, in other subject areas. In one instance, 11 student participants from one field of studies agreed that they were all going to attend the VW talk, and that they would all colour their avatar's hair in green, so that they could immediately recognise each other from the other 100 participants. I thought that this is another positive signal as to their acceptance of this modality of doing learning.
- I find it quite amazing that when I go out on campus, many of my students recognise me and they come to talk to me. The way they address me is totally familiar and my first thought is that "these people really know me". It is also quite interesting that I would have no idea of who they are until they tell me their names and then they too become familiar. All of a sudden, I know who they are, their history, the subject they teach. And then we become 'friends' in the real world - there are real smiles, real handshakes... the interesting part is that it had to take the virtual world to mediate that.
- It seems like their normal practices are being integrated inside the world, rather than the world influencing their practices. They are used to somehow presenting, working in groups towards one particular scope and they have never experienced other alternative approaches to teaching and learning. I have to be very careful here, because I can tread on thin ice, as they say. The fact that I am trying to reconcile an alternative form and approach to learning, which is based more on an informal, unstructured pathway with the more formalised, very well-structured, teacher training program, with a variety of

modules that mostly follow traditional face-to-face classroom-based approaches, carries a number of implications that cannot be underestimated.

- Now this is a very superficial way of evaluating a program so I don't feel that I need to enter into the merits of a simulation world. However, it is also interesting that the student participants feel this need to distinguish between the real "practical" teaching and what they do in-world. They do not seem to associate the importance of what they do in-world with how they behave or rather what they do in the real world. I think this is one of the most important barriers which we really need to overcome if we want our teachers to be not only receptive of the technology, but to adopt good practices in the classroom. I have now been noticing this attitude over these past 5-6 weeks and my feeling about this seems to be getting stronger as this experiment approaches the end. It seems like in our own VW, we have gone from the initial high to a dip in the curve (a trough of depression) as highlighted by Gartner's hype cycle[26]. However, rather than reaching a plateau, the dip seems to be getting lower and reaching the zero level. I ask, 'why is it that the student participants do not feel the compelling need to make use of the world?'
- Teaching and learning are a very complex exercise, because of the many different factors affecting human behaviour. Humans are affected by persons, objects and environments surrounding them. There is not one variable that might have more effect on the others. The world is an inanimate object in itself. The little intelligence it possesses is quite limited compared to what the human avatars can achieve with communication and collaboration. The learning that goes on in the world and the resulting changes in behaviour are a result of how the others (not just the participants) perceive this world. Implementing such an environment cannot be seen in isolation.

[26] Gartner's Hype Cycle emergent from the information technology research and advisory company, uses a cycle to represent the various stages in the acceptance, use and productivity associated with various technologies and applications such as VWs. Online: http://www.gartner.com/newsroom/id/2579615 Last Accessed: May 2014

APPENDIX 13: PARTICIPANT INFORMATION SHEET

UNIVERSITY OF MALTA

Study Information Sheet for Participants

Name of Project: Virtual World Connections: A pre-service teacher study on technology acceptance and adoption

Researcher: Vanessa Camilleri, University of Malta

Supervisor: Prof. Sara de Freitas (Serious Games Institute, University of Coventry)

Dear student,

I would like to invite you to take part in a research study, as part of my PhD studies with the Faculty of Education, at the University of Malta. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Talk to others about the study if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?
The study aims to investigate the effectiveness of 3D immersive spaces (virtual worlds) in the context of technology acceptance and adoption for pre-service teachers.

Why have I been invited?
You have been invited as the research involves pre-service teacher training. One of the study units, which as a pre-service teacher you will be following, is the 'Integration of Learning Technologies' in the practice of teaching. This investigation proposes to merge with this study-unit so that you will be able to experience the different learning technologies that one can use during teaching and learning in different ways.

Do I have to take part?
The study unit is a compulsory unit, for your PGCE course. However your participation in the actual research study is on a voluntary basis and should you wish, your collected data shall not be used for the purposes of the study. Please indicate your preference on the consent form (see attached) and your data will not be used for research purposes. We do, nonetheless, encourage you to appreciate your useful

contribution to the study in terms of both Educational Research and in the planning of our future teacher training courses.

What will taking part involve for me?

Your involvement in the study will not hinder your overall course progress in any way or pose any extra work than that which would normally be expected from students for any other study unit. The study unit is EDU4521 – Integrating Learning Technologies with an assigned value of 4ECTS.

Outline:

a) The data will be collected in the form of an online survey given at the start of the study-unit and after the study-unit period ends. These surveys will contain sections that will be indicative of technology acceptance and engagement. A link to these surveys will be sent to you via email.
b) Other data pertinent to your activities inside the virtual world will also be collected for the purpose of the research study.
c) A selected group of people may be chosen for a limited number of focus group sessions to gain a better understanding of how the virtual worlds may have affected your perceptions and attitudes in relation to learning technologies.
d) A selected group of people may also further be chosen to be included in an observation exercise during their 6-week teaching practice. This will in no way impinge on your teaching practice assessment activities and it will only be done to gain a better understanding of the long term effects of the VW experience on the behaviors and attitudes towards technology integration.
e) The study is expected to span a semester and this is expected to take place during the first semester of your academic year 2012/2013.
f) As a student you will be expected to contribute to the study unit by performing a series of tasks that are related to the unit content and thus contribute to your overall professional growth as a pre-service teacher.
g) As a participant you will get continuous feedback on your progress inside the virtual world.
h) The data collected throughout will only be used for the purpose of this research study.
i) Your anonymity, as a participant will be protected at all times, and at no point in the study will any indication or reference be made to specific individuals.
j) In addition you will also be asked not to divulge any information about other participants in the project to any unauthorized third parties.

What will I have to do?

You will need to sign a form giving your consent so that data can be used for the purposes of research. The data, which will be collected can be:

- Online surveys (pre- and post- research study)
- Virtual world activity logs
- Focus group session data
- Observation notes

You will also be asked to attend one information session so that the nature of this experiment is explained in more detail. Before the start of the study unit you will be free to participate in an orientation week which will be held inside the virtual world and at convenient time slots, so that you can be introduced to ways in which you can interact inside the world. The study unit will not bind you to specific time slots in which you have to be present in-world, but it will give you the opportunity to learn at your own pace and participate in tasks and activities that can enhance your understanding of how learning technologies can be applied to the classroom context.

What are the possible benefits of taking part?
By taking part in this study you will be able to contribute to educational research in terms of the different learning modes and modalities. Since the study will also be looking at learning technologies you will be able to experience technologies yourself, in a way that can help you with your every day classroom practice.

Thank you for reading this information sheet.

Van
Email: vanessa.camilleri@um.edu.mt
Mobile: 79065959

APPENDIX 14: PARTICIPANT CONSENT FORM

FACULTY OF EDUCATION, UNIVERSITY OF MALTA

RESEARCH ETHICS COMMITTEE

CONSENT FORM

Name of researcher: Vanessa Camilleri Mobile: 79065959

Address:

Statement of purpose of the study:
The scope of this study is to understand the effectiveness of the use of virtual worlds in the context of teaching and learning.

Methods of the development of the study:
The study-unit will be delivered inside a virtual world. I understand that I shall be followed throughout, and that all content and interactions will be accessible directly from the virtual world

Methods of data collection:
The data will be collected using a pre-test and post-test surveys. I understand that for the purposes of the study the surveys cannot be anonymized.
Another form of data collected will include monitoring of my activity inside the virtual world. I understand that the monitoring of this data will not be carried out outside the virtual world. I understand that I may also be chosen to form part of an additional focus group to better understand the mechanisms of the virtual world. I can also be selected to form part of some case study observations further on during my 6-week teaching practice. I also understand that the study will in no way carry negative implications on my course progress throughout the year.

Use made of the information:
All the data and information collected from this study will be used for research purposes only.

I hereby give my consent to participate in the study:
Yes/No

If **Yes**, I further give my consent to:

- fill in a pre-test – post-test survey

Yes/No

- have my in-world activities tracked in a statistical log

Yes/No

- if chosen, participate in a focus group session after the VW experience

Yes/No

- if chosen, be observed for a limited period during my teaching practice

Yes/No

Guarantees:

I, the researcher, will abide by the following conditions:

i. Your real name will not be published in the study.

ii. You will remain free to quit the study at any point and for whatever reason. In the case that you withdraw, all the records and information collected will be destroyed.

iii. In the event that you decide not to participate in the study, your assessment will in no way be affected.

iv. Deception in the data collection process will not be used.

v. Conclusions from the research will be communicated to you either verbally or in writing.

I, the participant, agree to the conditions above. I also agree **not** to divulge any information relating to the other individuals participating in the project to any other third party without any written authorisation.

Name of participant: _____

Signature:_____ Date:_____

Researcher's signature: _____[redacted]_____Date: _____

APPENDIX 15: ETHICS APPROVAL -University of Malta

EDU/084/12. -32

UNIVERSITY OF MALTA no sign supervisor.

UNIVERSITY RESEARCH ETHICS COMMITTEE

Check list to be included with UREC proposal form

Please make sure to tick **ALL** the items. Incomplete forms will not be accepted.

		YES	NOT APP.
1a.	Recruitment letter / Information sheet for subjects, in English	✓	
1b.	Recruitment letter / Information sheet for subjects, in Maltese	✓	
2a	Consent form, in English, signed by supervisor, and including your contact details	✓	
2b	Consent form, in Maltese, signed by supervisor, and including	✓	
3a	In the case of children or other vulnerable groups, consent forms for parents/ guardians, in English		✓
3b	In the case of children or other vulnerable groups, consent forms for parents/ guardians, in Maltese		✓
4a	Tests, questionnaires, interview or focus group questions, etc, in English	✓	
4b	Tests, questionnaires, interview or focus group questions, etc, in Maltese		✓
5a	Other institutional approval *for access to subjects*: Health Division, Directorate for Quality and Standards in Education, Department of Public Health, Curia...		✓
5b	Other institutional approval *for access to data*: Registrar, Data Protection Officer Health Division/Hospital, Directorate for Quality and Standards in Education, Department of Public Health...		✓
5c	Approval from person *directly responsible for subjects*: Medical Consultants, Nursing Officers, Head of School...		✓

Received by Faculty office on	19.6.12.
Discussed by Faculty Research Ethics Committee on	9.7.12
Discussed by university Research Ethics Committee on	14.9.12

1

To be completed by Faculty Research Ethics Committee

We have examined the above proposal and advise

Acceptance **Refusal** **Conditional acceptance**

For the following reason/s:

Signatur [redacted] Date 25th July 2012.

To be completed by University Research Ethics Committee

We have examined the above proposal and grant

Acceptance **Refusal** **Conditional acceptance**

For the following reason/s:

Signature [redacted] Date 27/9/2012

6

APPENDIX 16: ETHICS APPROVAL -Coventry University

REGISTRY RESEARCH UNIT

ETHICS REVIEW FEEDBACK FORM

(Review feedback should be completed within 10 working days)

Name of applicant: Vanessa Camilleri

Faculty/School/Department: [Faculty of Engineering and Computing] Post Graduate

Research project title: Virtual World Connections: A pre-service teacher study on technology acceptance and adoption

Comments by the reviewer

1. Evaluation of the ethics of the proposal: This is a low risk project - however the participant information sheet and informed consent form need to be included to progress.	
2. Evaluation of the participant information sheet and consent form: None seen	
3. Recommendation: (Please indicate as appropriate and advise on any conditions. If there any conditions, the applicant will be required to resubmit his/her application and this will be sent to the same reviewer).	
	Approved - no conditions attached
X	Approved with minor conditions (no need to re-submit)
	Conditional upon the following – please use additional sheets if necessary

☐	(please re-submit application)
☐	Rejected for the following reason(s) – please use other side if necessary
☐	Not required

Name of reviewer: Anonymous

Date: 14/03/2014